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Essays On Macroeconomics With Heterogeneity And Public Finance

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Abstract

This thesis focuses on how the design of public insurance policies entails distributional consequences that impact macroeconomic aggregates, inequality, and welfare. The first chapter assesses the general equilibrium effects of substituting the current U.S. income security system with a Universal Basic Income (UBI) policy. I develop an overlapping generations model with idiosyncratic income risk that incorporates intensive and extensive margins of labor supply, on-the-job learning, and child-bearing costs. I calibrate the model to the U.S. and conduct counterfactual analyses that implement reforms towards a UBI. I find that an expenditure-neutral reform has moderate impacts on agents' labor supply response but induces aggregate capital and output to grow due to larger precautionary savings. A UBI of $1,000 monthly requires a substantial increase in the tax rate of consumption used to clear the government budget and lead to an overall decrease in the aggregates. In both cases, the economy has more disposable income but less consumption at the bottom of their distributions. The UBI economy constitutes a welfare loss at the transition if expenditure-neutral and results in a gain in the second scenario. Despite relative losses, a majority of newborn households support both UBI reforms. The second chapter develops a heterogeneous agents model with history-dependent U.I. benefits built on stylized facts of the U.S. economy to quantitatively obtain an optimal U.I. program design. We first conduct an empirical analysis using the discontinuity of U.I. rules at state borders and find that a tenure requirement induces a longer employment spell. The monetary requirement decreases the number of employers and has a stronger effect on U.I. applications. The model can recover the sign of the relation between the requirements and the employment outcomes. When the tenure requirement is long, workers tend to accept more low paying jobs to become eligible sooner to U.I. and protect themselves from risk. The monetary requirement has the opposite effect. Due to its impact on moral hazard, the monetary requirement can generate higher levels of welfare than an increase in the length of the tenure requirement. The highest level of welfare is achieved by the optimization of both requirements.

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André Victor Doherty Luduvice

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ESSAYS ON MACROECONOMICS WITH HETEROGENEITY
AND PUBLIC FINANCE

To my grandparents.

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ABSTRACT

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Dirk Krueger

This thesis focuses on how the design of public insurance policies entails distributional consequences that impact macroeconomic aggregates, inequality, and welfare.

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and results in a gain in the second scenario. Despite relative losses, a majority of newborn households support both UBI reforms.

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Chapter 1

The Macroeconomic Effects of Universal Basic Income Programs

by André Victor Doherty Luduvice†

1.1 Introduction

A Universal Basic Income (UBI) is an unconditional transfer given to all citizens of a given region or country. In the last few years, pilot programs and experiments have been proposed, launched, or are ongoing in countries such as Canada, Brazil, Finland[1], Kenya, Switzerland, Uganda, and the United States[2]. The idea is far from new in Economics as similar concepts have been proposed by James Meade, Milton Friedman - with the Negative Income Tax -, Anthony Atkinson, among others (Meade, 1935;

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[1]The Finnish experiment has already been concluded. The program ran through 2017-18 and the preliminary results for the first year can be found in the recently released report (link).

[2]A few examples are the Y Combinator randomized control trial, the Stockton Economic Empowerment Demonstration in California, and the democratic candidate Andrew Yang's "Freedom Dividend" proposal. A longstanding program of unconditional transfers in the U.S. is the *Alaska Permanent Fund Dividend*, which will be later discussed in detail in this text.

Friedman, 1962; Atkinson, 1995) and has been long discussed by thinkers across all traditions of the political spectrum (Parijs and Vanderborght, 2017). In a nationwide context, the span of proposed policies is fairly broad: from large, one-time grants at the beginning of working age on top of the already existing programs to an entire substitution of the welfare system, including Social Security (SS) and health benefits (Murray, 2006; Thigpen, 2016).

The return of the UBI concept to the policy debate and, more recently, to the Economics literature, is due to both the economic incentives intrinsic to its simple design and to the recent set of trends in inequality, public finance and the labor market that have been attracting Economists' attention. On the incentives side, the UBI can potentially reduce inefficiencies at the microeconomic level. First, as it is a lump-sum transfer, it does not distort individuals' decisions and avoid threshold traps that might be induced by any means-testings. Second, it is untargeted and can yield a 100% take-up rate as it avoids stigma or any other latent frictions for program eligibility and applications. Third, it does not require any monitoring or bookkeeping and can reduce government operational costs.

In the last 20 years, there has been a steady growth of both federal spending and participation in means-tested income security programs such as the Earned Income Tax Credit (EITC) or the Supplemental Nutrition Assistance Program (SNAP). The eligibility requirements of such programs yield phase-out effects that generate discontinuities in after-tax income with effective marginal tax rates on the order of 30-39%, for more than 50% of low- and moderate-income households (CBO, 2013; CBO, 2015). At the same time, income inequality has sharply risen as the top 1% household earns today 24.1 times the median household income, a figure that was 8.6 in 1976 (Nakajima, 2017). While such growth of the very top is often addressed by the literature, the catching-up of the bottom when accruing its share of national income is a redistribution matter in which the UBI is often raised as a competitive instrument. Finally, the observed decline of labor force participation, especially among young men, when paired with the current and expected rise of automation, has triggered the concern on how to adapt the welfare system in an economic environment with pervasive joblessness (Michaels, 2017; Lowrey, 2018; Acemoglu and Restrepo, 2019).

However, as in any reform proposal, UBI-type programs gather significant drawbacks that raise skepticism towards both the effectiveness and the feasibility of its implementation (Ravaillon, 2018; Kearney and Mogstad, 2019). On top of the list of concerns is its potential large cost due to its universality and how it would be financed. Questions are raised regarding possible taxation counterparts that could be similarly as distortionary as means-testing thresholds or whether it could crowd-out the budget from other programs directed to poverty alleviation. A second concern is its potential disincentive to work due to large income effects, especially at the bottom of the income distribution, which leans the balance towards the need for work requirements in the EITC fashion. Lastly, there is the natural economic intuition of equating marginal utilities behind economic redistribution. The UBI is thus often argued as not intrinsically designed to generate equity since it pays same benefits to the rich and the poor.

This paper assesses the effects of substituting the current income security share of the U.S. welfare system for a UBI. Despite the growing momentum of the debate and the many unanswered questions, the macroeconomic literature still lacks a detailed understanding of what would be the general equilibrium, distributional and welfare effects of a large scale reform of the welfare system that implements a UBI. More specifically, what would be expected of the labor supply and accrual of disposable income for different strands of the distribution in such reconstruction and its overall effect on inequality. In order to tackle this task, I numerically solve a dynamic general equilibrium model that is able to provide micro-founded life-cycle and budgetary implications of such a broad welfare state reform as well as a normative assessment that relies on rich dynamics and heterogeneity taking into account the overall impact on inequality. With respect to the literature, this work is on the tradition of evaluating reforms and transfer programs in heterogeneous agents models (Lopez-Daneri, 2016; Pashchenko and Porapakkarm, 2017; Wellschmied, 2020; Ortigueira and Siassi, 2019; Guner, Kaygusuz, and Ventura, 2019a; Guner, Kaygusuz, and Ventura, 2019b; Hannusch, 2019; Berriel and Zilberman, 2011) and is an addition from the quantitative macroeconomics side to a growing list of recent studies that focus on the UBI policy (Jones and Marinescu, 2018; Hanna and Olken, 2018; Banerjee, Niehaus, and Suri, 2019; Ghatak and Maniquet, 2019; Hoynes and Rothstein, 2019; Daruich and Fernandez, 2020).

I develop a large-scale overlapping generations model with retirement and heterogeneity across households that incorporates both intensive and extensive margins of labor supply, human capital accumulation through labor market experience, and child-bearing costs. Households are also heterogeneous with respect to estimated permanent ability and idiosyncratic productivity shocks. The model has a welfare system composed of Social and Income Security (henceforth IS and SS systems) that mimics the U.S. structure accounting for means-testing requirements and its taxation counterparts. The IS system is composed of the Earned Income Tax Credit (EITC), means-tested transfers such as the Supplemental Nutrition Assistance Program (SNAP), the Temporary Assistance for Needy Families (TANF) and the Supplemental Security Income (SSI), the latter only available through retirement. The SS system is budget-balanced and pays retirement benefits to all households in the economy. I calibrate the model to the U.S. economy, and with this macroeconomic toolkit, I conduct counterfactual analyses of implementing reforms in the welfare system towards a UBI and evaluate the welfare implications of means-tested versus unconditional transfers.

In order to bring this model to the data, I estimate a wage process taking into account the target population of cash transfers recipients using the 2008 panel of the *Survey of Income and Program Participation* (SIPP) in a similar fashion to Heathcote, Storesletten, and Violante (2010) and calibrate parameters to match data moments. The model can successfully replicate both the non-targeted earnings and wealth distribution of the U.S due to a combination of the steepness of the earnings profile of high productivity households via human capital accumulation and the means-testing transfer schedule. In a further step, I conduct a counterfactual exercise in the model environment designed to approximate the effects of the Alaska Permanent Fund dividend. As empirically shown in Jones and Marinescu (2018), this program has macroeconomic outcomes, and the model is able to, in an off-sample fashion, generate aggregate responses that are in the same sign an order of magnitude of the ones estimated. Moreover, by disentangling partial and general equilibrium effects, I show that the model requires the latter and the adjustment of labor supply to the change in the competitive wage to better match the evidence in the data.

The first counterfactual I implement is an expenditure-neutral reform that keeps constant the total amount of budget outlays in transfers and let the tax rate on consumption endogenously adjust to balance the government's budget. The aggregate response encompasses an increase of 6% in physical capital with an accompanying decrease in the equilibrium interest rate. The result is driven by agents that, early in their life-cycle, are at the bottom of the wealth distribution in the benchmark scenario and now save more due to the absence of means-testing and the average level of transfers in the counterfactual economy. Pushed by an increase in the aggregate capital, output increases by 4%. The income effect generated by the transfers affects the aggregate labor market inducing a small increase in total hours, reflecting the rise in the intensive margin of releasing households from the incentive to work less in order to fall inside the means-testing brackets. At the same time, the extensive margin reacts in the opposite direction with a decrease of labor force participation of 1 percentage point. This reform reduces the tax effort towards revenues as the endogenous tax rate on consumption decreases from 6.7% to 5.7%.

In my second counterfactual exercise, I implement a UBI reform similar to the one proposed by Andrew Yang - Democratic presidential candidate for the 2020 elections in the US. I let the level of aggregate transfers be the equivalent of 20% of output in the benchmark economy. This yields a transfer of approximately US$12,000 annually to each household in the economy. In this scenario, - and not surprisingly - the tax rate on consumption needs to increase 32 percentage points in order to balance the government's budget. The aggregate response of the economy is a contraction of both capital and output, stemming simultaneously from the drop in hours, the decline in labor force participation, and the decrease of precautionary savings motive at the bottom generated by the high level of the consumption floor. In terms of the impact on inequality, the second UBI reform increases the Gini coefficient for pre-tax earnings and wealth, mostly due to the selection mechanism arising from the high productivity agents that remain in the labor force and can buffer consumption through a higher level of savings. However, inequality in disposable income at the very bottom of the distribution decreases in both cases, driven by a reduction of the means accrued by the middle-class. This result is followed by less consumption redistribution towards the same bottom 20% in both economies, which is reshufflled towards the middle-class.

I also conduct a normative analysis of the reforms by evaluating the model's responses in welfare. Under a utilitarian Social Welfare Function, the Consumption Equivalent Variation required for the UBI alternative to attain the same level of welfare of the current system at the beginning of the life-cycle is of -0.24%. Alternatively, the generous UBI transfer improves welfare by 1.22%. The transitional dynamics towards the generous UBI economy exhibits differences in welfare relative to the steady-state levels due to the sharp drop in labor coupled with a slow adjustment in capital. The decomposition of welfare at the age dimension shows that the welfare losses in the first counterfactual scenario are more pronounced during earlier ages, as households that have children receive lower transfers when compared to the ones of the means-tested system, which includes the different brackets per children of the EITC. The second reform has gains across all generations alive at the period of the reform. Both counterfactuals can constitute a majority of winners that would vote in favor of the reform. The share of winners closely tracks the age breakdown, with approval of 80.4% for the second proposal. Moreover, the first counterfactual is beneficial to high ability households, while the second counterfactual is preferred by the ones with low ability.

This paper is organized as follows. In the next section, I present a review of the related literature. In Section 2.4, I construct the setting of my quantitative model, provide intuition about the underlying theory, and define the recursive competitive equilibrium. In the subsequent Section 2.5, I describe the calibration used to map the model to the data. Section 2.6 presents the results for the Benchmark Economy and the properties of the initial steady-state. Section 1.6 lays-out the quantitative exercises explored and the results for two counterfactual UBI reforms. In Section 1.7, I explore the results for the transitional dynamics between the initial steady-state and the final steady-state of the reforms. Section 1.8 conducts the normative evaluation of the reforms by exploring different measures of welfare. The last section states my conclusions.

1.2 Related Literature

I begin by briefly discussing the empirical evidence on the labor market effect of unconditional transfers. In a comprehensive summary, Marinescu (2017) documents the empirical findings of related experiments such as the NIT, casino dividends recipients, and lottery winners. She observes that overall, in such programs, there is either no effect on labor market supply or a slight but not statistically significant reduction in work and earnings. For the case of Permanent Fund, one of the few clear examples of windfall transfers in a wide geographic region, Jones and Marinescu (2018) use a synthetic control method and find that the dividend cash transfer had no effect on the employment to population ratio and increased part-time work by 1.8 percentage point, suggesting a close to zero income effect for the extensive margin. In section 1.5.3, I will refer to these estimates and use them as a validation of the general equilibrium effects of my model. I include below other relevant measurements that, though not used explicitly in this paper, are also relevant for the underlying debate of the distinction between macro and micro labor supply responses to transfers.

A small response of labor supply is also confirmed by a windfall cash transfer program held in Iran that substitutes energy subsidies and reaches more than 70 million citizens, yielding a take-up rate of about 95%. The evidence is in Salehi-Isfahani and Mostafazi-Dehzooei (2018) who analyze a rich panel of households and find no discernible negative labor supply effect, both on hours or labor force participation, with positive otucomes for women and self-employed men. In the opposite direction, a study by Giupponi (2019) on welfare transfers based on spouse's death uses Italian administrative data to estimate the income effect of losing the benefit. She estimates a marginal propensity to earn out of unearned income of approximately -1.0, indicating a larger response than the previously observed in the literature. Lastly, a recent evidence by Egger et al. (2019) estimates behavioral and general equilibrium impacts of large cash transfers in rural villages in Kenya. Authors do not observe meaningful changes in the labor supply of treated households, with increase in spending and a local fiscal multiplier of 2.5.

The long-term effect of transfers is estimated by Price and Song (2017) for the participants in the Seattle-Denver Income Maintenance Experiment, a program inspired by the NIT proposal. Following adults for over four decades using Social Security data, authors find that the treatment decreased earned income during the experiment, caused no significant effect immediately after it, and decreased earnings later in life. In the paper, the authors argue that the latter arises due to the interaction of a stronger preference for leisure in older ages and extra accumulated wealth. On the other hand, while further confirming the small labor supply evidence, but suggesting that it does not change at older ages, Cesarini et al. (2017) study the wealth effect of lottery prizes in Sweden. Authors find that winners slightly reduce earnings being persistent and similar by age, education, and sex.

Turning to akin settings to my quantitative model, Fabre, Pallage, and Zimmermann (2014) is an early work where authors compare the welfare effects of unemployment insurance (UI) against the UBI finding that the former is socially robust to the introduction of the latter. Despite drawbacks embedded in UI, such as moral hazard and government monitoring costs, the authors argue that it would take empirically implausible values for the parameters associated with these costs to make a UBI socially preferred. The main reason is that, in the mechanism proposed under incomplete markets, the UI insures agents in states of the world when they need the most. Lopez-Daneri (2016) is a key reference to our proposed framework as it studies a revenue-neutral reform of the U.S. income tax and welfare system to an NIT. The author calibrates a life-cycle model to the U.S. economy with welfare payments in a non-linear function of income and a lump-sum payment of retirement benefits. Focusing on an equilibrium with transitional dynamics for an open economy, the author finds that the optimal NIT imposes a 22% marginal tax rate and a transfer of 11% of GDP of the benchmark economy with an ex-ante welfare gain of 2.1%.

In a working paper, Ortigueira and Siassi (2019) develop a structural dynamic model with a rich system of means-tested, anti-poverty transfers where households make not only the standard consumption and savings decisions but also family formation and program participation. Authors find in their model that lone mothers have large incentives to work, with low-productive ones receiving, on average, a participation subsidy amounting to 15% of their labor earnings. Also, asset testing and eligibility to programs such as the SNAP or TANF introduce substntial distortions in low -productive workers' savings decisions, a point discussed in detail in Wellschmied (2020). In the context of Medicaid, Pashchenko and Porapakkarm (2017) show that assets-testing can reduce labor supply distortions in an environment with unobserved productivity. More recently, Daruich and Fernandez (2020) provide a general equilibrium approach to a UBI reform with focus on skill investments during early childhood.

My paper adds to this literature by framing a policy scenario of a reform towards a UBI as a substitution of the IS system. Moreover, I follow Ortigueira and Siassi (2019) and Wellschmied (2020) and extend the standard modeling framework to explicitly outline the IS system and the many brackets for the different means-testing requirements in an overlapping generations economy. A novel part consists of the interaction of such a system with the operative extensive and intensive margins of labor supply modeled as in Chang et al. (2019), which yields a mechanism that allows me to understand the trade-off of both margins under the different policies. I account for human capital accumulation based on labor market experience as in Attanasio, Low, and Sanchez-Marcos (2008), Guner, Kaygusuz, and Ventura (2019a), Guner, Kaygusuz, and Ventura (2019b), and Hannusch (2019), and combine all such ingredients in a general equilibrium framework taking into account the transitional dynamics. The equilibrium component can be understood as complementary to the approach in dynamic structural models of labor supply, such as in Marc K. Chan (2013), to the approach in public economics in Saez (2002), Brewer, Saez, and Shephard (2008), and Rothstein (2010), and other ones reviewed by Mark K. Chan and Moffitt (2018).

As the interest in the Universal Basic Income has been sharply growing in the last few years, there is a set of recent papers that study the UBI phenomenon through different perspectives. Hanna and Olken (2018) use data from Indonesia and Peru to analyze the trade-offs involved in proxy targeting versus universal basic income. Banerjee, Niehaus, and Suri (2019) draw from the evidence of cash transfer programs in developing countries to anticipate the potential effects of a UBI as an incremental policy focused on poverty mitigation. Ghatak and Maniquet (2019) develop and study a theoretical framework to assess the normative justifications of a UBI system. Finally, and in close relation to the scope of this paper, Hoynes and Rothstein (2019) study the role of UBIs in advanced economies with a descriptive framework that encompasses different policy designs. They forecast that a UBI would direct larger transfers to childless and middle-income rather than poor households. The main contribution of this paper from the perspective of this literature is thus to add a macroeconomic framework that can serve as a quantitative laboratory to assess the impact of a nationwide reform of the welfare system and deliver precise predictions to many of the unanswered questions raised in the papers.

1.3 The Model

This section describes the dynamic general equilibrium model I use to analyze the macroeconomic effects of a reform of the welfare system in the U.S. towards a Universal Basic Income. The environment is a life-cycle, overlapping generations economy with incomplete markets and individual heterogeneity, endogenous labor supply, human capital accumulation, and a tax and transfers system similar to the one of the U.S.

Households are heterogeneous with respect to their age, $j \in \{1, \ldots, J\}$, permanent ability, $\theta \in \Theta$, idiosyncratic productivity shock, $z \in \mathcal{Z}$, human capital stock, $h \in \mathcal{H}$, and asset holdings $a \in \mathcal{A}$. I also model an extra degree of heterogeneity in the family structure by allowing households to differ on child-bearing as it is one of the key determinants for the allocation within the U.S. tax code, thus keeping track of whether households are child-bearers or not, $k \in \mathcal{K} = \{0, 1\}$. The state space of the economy is then the set $S = \mathcal{A} \times \mathcal{H} \times \mathcal{Z} \times \mathcal{K} \times \Theta \times \{1, \ldots, J\}$. In the subsections below, I discuss in detail every entry of the individual state space element $s = (a, h, z, k, \theta, j) \in S$.

As the environment is set with the the underlying purpose of assesing a reform of the transfer system that will be analyzed both in steady-states and along the transition, throughout the description of the model, I will selectively omit indices in order to avoid loading the notation. More specifically, I will denote all individual variables as defined over the individual state-space s, hence age-dependent and thus implicitly indexed by j. However, they should also be understood as implicitly indexed by time t. As the aggregate variables are more naturally understood to be time-dependent, I will explicitly index them by t.

1.3.1 Demographics

Each model period stands for one year. Time t is discrete with infinite horizon and the economy is populated by a continuum of mass one of households who live at most J years. There is uncertainty regarding the time of death in every age $j = 1, \dots, J$ so that the household faces probability ψ_j of surviving to age j. Therefore, in every period, a fraction of the household population dies and leaves accidental bequests q. The age profile of the population $\{\mu_t\}_{j=1}^{J}$ is modeled by assuming that the fraction of households with age j in the population is given by the law of motion $\mu_j = \frac{\psi_j}{(1+g_n)}\mu_{j-1}$, that satisfies $\sum_{j=1}^{J} \mu_j = 1$, and where g_n is the population growth rate.

I assume that the household does not decide the number of children or when to have them in a similar fashion to Attanasio, Low, and Sanchez-Marcos (2008). At every period t, a fraction p_k of the households is defined to have children during their life-cycle, and are then flagged by $k = 1$. When they do so, they all have simultaneously the same number of children which solely depends exogenously on their age. Households have a number of kids $n_{k,j}$ at age j who are born in working ages $\underline{j}^i$, with $i \in I$, where I is finite. I also assume that children live in the household until they are 18 years old[3]. Given this structure, by knowing age j and the different ages when children are born $\underline{j}^i$, we can count the number of children in the household $n_{k,j}$, as follows:

$$n_{k,j} = \sum_{i \in I} \mathbb{1}\left[\underline{j}^i \leq j \leq \underline{j}^i + 17\right]. \tag{1.1}$$

Households with children pay a child-care cost η whenever they are working with any young children in the household, defined to be between zero and two years old.

[3] Here I follow the same interpretation of Attanasio, Low, and Sanchez-Marcos (2008) used in Fehr and F. Kindermann (2018).

At the aggregate level, I define the sum of such costs as CC_t.

1.3.2 Preferences

Households have a time-separable period utility function, maximize their discounted expected lifetime utility from nondurable goods consumption c and labor supply l. It is defined as follows

$$\mathbb{E}\left[\sum_{j=1}^{J}\beta^{j-1}\left(\prod_{i=1}^{j}\psi_i\right)u(c,l)\right], \tag{1.2}$$

where β is the discount factor and $\mathbb{E}$ is the expectation operator.

1.3.3 Technology

There is a single good produced in this economy with technology given by a Cobb-Douglas production function that exhibits constant returns to scale, $Y = F(K_t, L_t) = K_t^{\alpha}L_t^{1-\alpha}$, where $\alpha \in (0,1)$ is the output share of capital income and Y_t, K_t and L_t denote, respectively, aggregate output, physical capital and labor. The final good can be consumed or invested in physical capital on a one-to-one basis.

The price of the consumption good is normalized to one and aggregate investment in physical capital, I_t, is defined by the following law of motion:

$$K_{t+1} = (1-\delta_k)K_t + I_t, \tag{1.3}$$

where δ_k is the depreciation rate of physical capital.

This technology is used by a representative firm that behaves competitively maximizing profits at every period t by choosing labor and capital given factor prices.

The profit maximization problem is:

$$\Pi_t = \max_{K_t, L_t} K_t^{\alpha} L_t^{1-\alpha} - w_t L_t - (r_t + \delta_k) K_t. \tag{1.4}$$

which yields the following first-order conditions:

$$r_t = \alpha \left(\frac{K_t}{L_t} \right)^{\alpha - 1} - \delta_k \tag{1.5}$$

$$w_t = (1 - \alpha) \left(\frac{K_t}{L_t} \right)^{\alpha} \tag{1.6}$$

1.3.4 Endowments and Labor Income

Agents are born with zero assets, endowed with one unit of time, and forcefully retire at age J_R. While working, individual wage depends on the competitive wage w_t, a permanent ability shock $\theta \sim N(0, \sigma_\theta^2)$, human capital level h_j, and an idiosyncratic persistent shock z_j.

I assume that households can only choose their hours within the set $[0, 1]$ and are subject to a non-convexity associated with set-up costs for work - such as commuting time - as in Chang et al. (2019). I define then $\ell(l)$ to be the effective hours of work and use the following functional form to account for this effect:

$$\ell(l) = \max\left\{0, l - \bar{l}\,\right\},\ l \in [0, 1], \tag{1.7}$$

where l is the individual labor supply and $0 < \bar{l} < 1$.

The function in (1.7) above imposes a wedge in the mapping between chosen hours and labor earnings and it gives rise to adjustments along the extensive and intensive margins as in Prescott, Rogerson, and Wallenius (2009). It can also be understood in the same fashion as the non-linearity of such mapping in Erosa, Fuster, and Kambourov (2016).

Moreover, this formulation is particularly suited to the nature of this paper's question, which calls for precise predictions about the behavior of the labor supply and allows sharp distinctions between participation and movements through part-time and full-time work[4]. This characterization is useful later in the validation of the model in section 1.5.3.

Households pre-tax labor income is then defined by:

$$y(l, h_j, z_j) = \quad w \cdot \exp(\theta) \cdot \exp(z_j) \cdot h_j \cdot \ell(l) \tag{1.8}$$

I follow the approach used in Attanasio, Low, and Sanchez-Marcos (2008) and Guner, Kaygusuz, and Ventura (2019a) and Guner, Kaygusuz, and Ventura (2019b) and assume that the human capital component evolves according to a law of motion that takes into account the increasing return on wage due to labor market experience:

$$h_{j+1} = H(h_j, l, j; \nu, \delta_h) = \exp\left[\ \ln h_j + (\nu_1 + \nu_2 \cdot j)\, \mathbb{1}_{[l_j>0]} - \delta_h \left(1 - \mathbb{1}_{[l_j>0]}\right)\ \right] \tag{1.9}$$

where ν_1 captures the positive effect of working, ν_2 is the diminishing marginal return of the incremental year in the labor force, and δ_h stands for the depreciation rate of the human capital stock when out of the labor force[5]. I define the aggregate level

[4] As emphasized in Chang et al. (2019), in this setting, adjustments along the intensive margin generate larger increases in efficiency units than those along the extensive margin. Due to this, I report, among other relevant moments, the mean aggregate efficiency units of labor.

[5] Here, I also follow the interpretation used in Fehr and F. Kindermann (2018).

of human capital by HC_t. The idiosyncratic component z_j follows an AR(1) process defined by :

$$z_{j+1} = \rho z_j + \varepsilon_j,\ \varepsilon_j \sim N(0, \sigma_\varepsilon^2) \tag{1.10}$$

which is discretized in a Markov chain with transition matrix $\pi_{z,z'} = \Pr(z_{j+1} = z'|z_j = z)$ and stationary distribution $\Pi(z)$.

From age J_R and onwards labour supply is forcefully zero and agents live off potential transfers, retirement benefits and accumulated wealth. I also assume that there is no altruistic bequest motive and there is the certainty of death at $J+1$. Hence, agents alive at age J consume all resources, implying $a_{J+1} = 0$.

1.3.5 Government

The government runs a welfare system designed to mimic the one of the U.S. economy, has pure public spending G_t, payments of its debt stock B_t, and collect taxes from households to finance it. I assume that both spending and public debt are defined by exogenous and constant shares of Y_t given by b_G and b_B, respectively.

The revenue to finance welfare and spendings is levied by an exogenous tax rate on capital income, τ_r, a non-linear, exogenous, and progressive tax schedule on labor income, $T_l(y)$, and an endogenous tax rate on consumption $\tau_{c,t}$ that adjusts to balance the government budget. Finally, an endogenous payroll tax rate $\tau_{SS,t}$ separately balances the budget of the Social Security system.

The labor income tax function is given by $T_l(y) = y_j - \tau_0 y^{(1-\tau_1)}$, where τ_0 is the scale parameter that defines the level of the average tax rate and τ_1 is the parameter that governs the degree of progressivity implied by the curvature of the function. This formulation was initially used in Benabou (2002) and has recently become the benchmark in the literature measuring the impact of top-income taxation in government revenue in general equilibrium economies with heterogeneous agents (Guner, Lopez-Daneri, and Ventura, 2016; Heathcote, Storesletten, and Violante, 2017; Holter, Krueger, and Stepanchuk, 2019). I denote by TL_t the aggregate level of labor income tax collected.

The Income Security system (IS) is composed of the Earned Income Tax Credit (EITC), other means-tested cash transfers such as the Suplemental Nutrition Assistance Program (SNAP) or the Temporary Assistance for Needy Families (TANF), and the Supplemental Security Income (SSI), available only when agents retire. I model the brackets and testing details of the EITC exactly as defined by the *Internal Revenue Services* (IRS) by following the formulations in Ortigueira and Siassi (2019), and use a simplified way modelling of the SNAP and TANF programs for tractability purposes in a similar fashion to Wellschmied (2020). The SSI is modeled as defined by the U.S. *Social Security Administration* (SSA).

First, it is helpful to lay out key definitions used in the characterization of the transfer programs. Total labor income $y(l, h_j, z_j)$ will henceforth stand for *gross income* and $d = ra$ for *investment income*. I also need to define *gross adjusted income* as $y_a \equiv y(l, h_j, z_j) + d$. The EITC is a refundable credit in which the eligibility is determined by two criteria: first, investment income cannot exceed a level $\bar{d}_{TC}$ and second, gross adjusted income cannot be higher than an upper bound $\bar{y}_{TC}^k$ which depends on the number of children $n_{k,j}$ present in the household. As it is defined as a percentage of positive labor income y, it is, in essence, a work subsidy. The payment structure is composed by three parts: a phase-in region, a so-called plateau region, and a subsequent phase-out region.

The individual level of transfers for the EITC is defined as T_{TC} and the overall structure is summarized as follows:

$$T_{TC}[y,d,j] = \begin{cases} \kappa_1^k y, & \text{if } 0 \leq y < \underline{y}^k \\ \kappa_1^k \underline{y}^k, & \text{if } \underline{y}^k \leq y < \bar{y}^k \\ \max\{\kappa_1^k \underline{y}^k - \kappa_2^k (y - \bar{y}^k), 0\}, & y > \bar{y}^k \\ 0, & \text{if } d > \bar{d}_{TC} \text{ or } y_a > \bar{y}_{TC}^k \text{ or } j \geq J_R \end{cases} \tag{1.11}$$

where κ_1^k and κ_2^k are the phase-in and phase-out rates, respectively, and $\underline{y}^k$ and $\bar{y}^k$ are the income thresholds for the plateau. Note that all brackets are indexed by k, which stands for the dependance on the number of children $n_{k,j}$. The investment eligibility requirement, on the other hand, is invariant to such number. I define the total aggregate level of transfers paid via the EITC by TTC_t, standing for *total tax credit*.

I model the other means-tested cash transfer programs in a similar fashion, with the difference that now thresholds are on households' asset holdings and adjusted income, as it is defined in the tax code for both the SNAP and the TANF. The SSI, given the absence of labor income during retirement, is only tested for households' asset level. I denote thie maximum level of assets for both the TANF and the SNAP as $\bar{d}_{CT}$, and the maximum level of adjusted income for the SNAP as $\bar{y}_{CT}$. I abstract from all other qualitative requirements for eligibility regarding family size or co-habitation of parents for households with children as well as the tapering in their phase-out brackets.

The payment schedule for the individual level of transfers T_{CT} for such programs is thus defined below:

$$T_{CT}[y_a, a, j] = \begin{cases} t_{SNAP}, & \text{if } a \leq \bar{d}_{CT} \text{ and } y_a \leq \bar{y}_{CT} \text{ and } j < J_R \\ t_{SSI}, & \text{if } a \leq \bar{d}_{SSI} \text{ and } j \geq J_R \\ 0, & \text{otherwise} \end{cases} \tag{1.12}$$

where t_{SNAP} and t_{SSI} are the transfer values. I denote the total aggregate level of cash transfers by TCT_t, standing for *total cash transfers*. The total expenditure of the government on means-tested cash transfers is then defined as the sum $TR_t = TTC_t + TCT_t$.

The SS system is operated in a pay-as-you-go schedule. It is balanced by a payroll tax rate $\tau_{SS,t}$ and pays retirement benefits independent of individuals' history defined by $b(x_t) = b_{SS}x_t$, where b_{SS} is the replacement rate and x_t is the average level of labor earnings of period $t-1$, normalized by the measure of working households.

At last, I also assume that the government is responsible for collecting all accidental bequests q_j, denoted by Q_t when at the aggregate level. Hence, at any time t the budget of the tax system is balanced if, and only if,

$$G_t + (1 + r_t)B_t + TR_t = \tau_{c,t}C_t + TL_t + \tau_r r_t A_t + Q_t + (1 + g_n)B_{t+1}. \tag{1.13}$$

Here we have that, in the aggregate, the transition path is characterized by several time-dependent endogenous objects, including the government's debt. This formulation follows the one in Fabian Kindermann and Krueger (2018) and, by assumption, the govenment does not run fiscal deficits to ensure satisfaction of its budget constraint.

1.3.6 Recursive Household Problem

Let $v(s)$ denote the value function of a j year old agent. As defined previously, $s = (a, h, z, k, \theta, j) \in S$ is the individual state space. Also, let $v^R(s)$ for $j = J_R, \ldots, J$ denote the value function of an individual aged j who is retired and receives Social Security benefits. I normalize the value function of the terminal age J to zero, $v^R(s_{-j}, J+1) = 0$, where henceforth s_{-j} stands for the individual state-space without the age dimension.

The problem of an agent with age $j = 1, \ldots, J_R - 1$ that lies inside the fraction p_k of the population that bears children in their life-cycle is represented in the recursive form in the Bellman equation (1.14) below. For the agents inside the fraction $(1-p_k)$, the definition is identical with $k = 0$, $\forall j$.

$$v(a, h, z; k = 1, \theta, j) = \max_{c, a', l} u(c, l) + \beta \psi_{j+1} \mathbb{E}_z \left[v(a', h', z'; k = 1, \theta, j+1) \right]$$

s.t.

$$\tag{1.14}$$

$$\begin{aligned}(1+\tau_c)c + a' + \eta \mathbb{1}_{\left[l > \bar{l},\, (j - \underline{j}^i) \leq 2\right]} &= a(1 + r(1-\tau_r)) + (1 - \tau_{SS}) y(l, h, z) \\ &\quad - T_l[y(l, h, z)] + T_{TC}[y(l, h, z), d, j] + T_{CT}[y_a, a, j]\end{aligned}$$

$$y(l, h, z) = w \exp(z + \theta) h \ell(l), \quad h' = H(h, l, j; \nu, \delta_h)$$

$$n_{k, j+1} = \sum_{i \in I} \mathbb{1} \left[\underline{j}^i \leq j + 1 \leq \underline{j}^i + 17 \right]$$

$$c > 0, \qquad a' \geq 0, \qquad 0 \leq l \leq 1$$

For individuals at ages $j = J_R, \ldots, J$ the problem is:

$$v^R(a,j) = \max_{c,a'} u(c,0) + \beta\psi_{j+1} v^R(a', j+1)$$

s.t.

$$(1+\tau_c)c + a' = a(1+r(1-\tau_r)) + b(x) + T_{CT}[0,a,j] \tag{1.15}$$

$$c > 0, \quad a' \geq 0$$

The solution of the dynamic programs (1.14) and (1.15) provides us the decision rules for the asset holdings $a : S \to \mathbb{R}_+$, consumption $c : S \to \mathbb{R}_{++}$, and labour supply $l : S \to [0,1]$.

1.3.7 Equilibrium

Agents are heterogeneous at each point in time in the state $s \in S$. The agents' distribution among the states s is described by a measure of probability Φ_t defined on subsets of the state space S. Let $(S, \mathcal{B}(S), \Phi_t)$ be a space of probability, where $\mathcal{B}(S)$ is the Borel σ-algebra on S. For each $\omega \subset \mathcal{B}(S)$, $\Phi_t(\omega)$ denotes the fraction of agents that are in probability state ω. There is a transition function $M_t(s,\omega)$ which governs the movement over the state space from time t to time $t+1$ and that depends on the invariant probability distribution of the idiosyncratic shock $\Pi(z)$ and on the decision rules obtained from the household's problem.

The definition below stands for the recursive competitive equilibrium. The definition for the stationary equilibrium can be found in Section 1.A.4 of the Appendix.

Definition 1 (Recursive Competitive Equilibrium). *A recursive competitive equilibrium with population growth for this economy is an allocation of value functions* $\{v_t(s), v_t^R(s)\}_{t=0}^{\infty}$*, policy functions* $\{c_t(s), a_t'(s), l_t(s)\}_{t=0}^{\infty}$*, prices* $\{w_t, r_t\}_{t=0}^{\infty}$*, productions plans for the firm* $\{K_t, L_t\}_{t=0}^{\infty}$*, consumption taxes* $\{\tau_{c,t}\}_{t=0}^{\infty}$*, social security taxes and benefits* $\{\tau_{SS,t}, b(x_t)\}_{t=0}^{\infty}$*, aggregate transfers* $\{TR_t\}_{t=0}^{\infty}$*, government expenditures and debt* $\{G_t, B_t\}_{t=0}^{\infty}$*, accidental bequests* $\{Q_t\}_{t=0}^{\infty}$*, and an age-dependent measure of agents* $\{\Phi_t\}_{t=0}^{\infty}$*, such that,* $\forall t$*:*

1. *Given factor prices, taxes and transfers, and initial conditions, the value functions* $\{v_t(s), v_t^R(s)\}$ *and policy functions* $\{a_t'(s), c_t(s), l_t(s)\}$ *solve the households' optimization problems (1.14) and (1.15);*

2. *The individual and aggregate behaviours are consistent:*

$$G_t = g_y Y_t, \;\; B_t = g_b Y_t$$

$$(1 + g_n)K_{t+1} = \int_S a_t'(s) d\Phi_t(s) - (1 + g_n)B_{t+1}$$

$$C_t = \int_S c_t(s) d\Phi_t(s)$$

$$L_t = \int_S \exp(\theta + z_j) h_t(s) \ell(l_t(s)) d\Phi_t\left(s_{-j}, \{1, \ldots, J_R - 1\}\right)$$

3. $\{r_t, w_t\}$ *are such that they satisfy the firm's first-order conditions (2.5) and (2.6);*

4. *The final good market clears:*

$$C_t + K_{t+1} + G_t + CC_t = AK_t^{\alpha} L_t^{1-\alpha} + (1 - \delta_k)K_t$$

5. *The Government balances its budget:*

$$G_t + \int_S \left[T_{TC,t}(s) + T_{CT,t}(s)\right] d\Phi_t(s) + (1+r_t)B_t = Q_t +$$
$$\int_S \left[\tau_r r_t a_t(s) + \tau_{c,t} c_t(s) + \left(y_t(s) - \tau_0 y_t(s)^{(1-\tau_1)}\right)\right] d\Phi_t(s) + (1+g_n)B_{t+1}$$

6. *Social Security's budget balances:*

$$\tau_{SS,t} w_t L_t = \int_S b(x_t) d\Phi_t\left(s_{-j}, \{J_R, \ldots, J\}\right)$$

7. *Accidental bequests equals the savings left from deceased households:*

$$Q_t = \int_S (1-\psi_{j+1}) a_t'(s)\, d\Phi_t(s)$$

8. *Given the decision rules, Φ_t satisfies:*

$$\Phi_{t+1}(\omega) = \int_S M_t(s,\omega) d\Phi_t(s),\ \forall \omega \subset \mathcal{B}(S),$$

where $M_t : (S, \mathcal{B}(S)) \rightarrow (S, \mathcal{B}(S))$, can be written as folllows: $\forall j \in \{2, \ldots, J\}$,

$$M_t(s,\omega) = \begin{cases} \pi_{z,z'} \cdot \psi_{j+1}\ , \quad \textit{if}\ \ a_t'(s) \in \mathcal{A},\ h_t'(s) \in \mathcal{H},\ k \in \mathcal{K},\ \theta \in \Theta,\ j+1 \in \{2, \ldots, J\} \\ 0\ ,\ \textit{otherwise.} \end{cases}$$

and for $j \in \{1\}$,

$$\Phi_{t+1}\left(S_{-J},1\right)=(1+g_n)^t\begin{cases}\displaystyle\sum_{k\in\mathcal{K},\,\theta\in\Theta} p_k\cdot p_\theta\;, & \textit{if } 0\in\mathcal{A},\ h_0\in\mathcal{H},\ \bar{z}\in\mathcal{Z}\\ 0\;,\ \textit{otherwise,} & \end{cases}$$

where p_k and p_θ are, respectively, the probabilities of being a household with children and of drawing θ out of its discretized distribution. The initial conditions are $a_0 = 0$, $h_0 = 1$, and $\bar{z}$, the average level of productivity.

1.4 Calibration

1.4.1 Demographics

In the model agents are born at $j = 1$ which stands for age 20 in real life, start their retirement at age $J_R = 45$, standing for 65 in real life, and die with probability one at age $J = 80$, equivalent to 100 years old. The age-dependent survival probabilities $\{\psi_j\}_{j=1}^{J}$ are the ones estimated by Fehr and F. Kindermann (2018) for the U.S. population in 2010. The population growth is set to be $g_n = 1.1\%$, the average long run value for the US. I set the fraction of households that will have children during their lifespan to $p_k = 30\%$. They will have three children born at ages $\underline{j}^i = \{27, 30, 33\}$, being then $I = \{1, 2, 3\}$ in equation (1.1) that defines the number of children at age j, $n_{k,j}$ (Fehr and F. Kindermann, 2018). The number of children is set to a maximum of 3 due to the design of the EITC as defined by the IRS. More details are discussed in Appendix 1.A.3.

1.4.2 Preferences

The period utility is

$$u(c,l) = \log(c) - \varphi \frac{l^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}} \tag{1.16}$$

where φ controls intensity of labor vs. consumption, γ governs the Frisch elasticity. Preferences are in King-Plosser-Rebelo form and are consistent with a balanced growth path.

I set $\gamma = 1$ as in Lopez-Daneri (2016). I jointly and endogenously calibrate φ and $\bar{l}$, so that the aggregate average hours dedicated to work are a third of the household's unit endowment of time $H = 33\%$ and the Labor Force Participation rate (LFP) is 73.9%. The first number is standard in the literature and the second one is calculated using the data of the *Bureau of Labor Statistics* (BLS) taken from *Current Population Survey* (CPS) for males older than 20. In order to smooth the effect of recent changes in the secular trend of this statistic, I calculate separately the LFP for this range for 2008 (75.6%) and 2018 (72.2%) and reach the targeted moment by taking a simple average of them[6]. Finally, I endogenously calibrate the time discount factor β to match a capital-output ratio of $K/Y = 2.9$, as in Fabian Kindermann and Krueger (2018).

1.4.3 Technology

I set the capital share of the economy to be $\alpha = 35\%$ as in Lopez-Daneri (2016), which is the average in the U.S. between 1960-2007. I calibrate the depreciation rate of capital δ_k so that the benchmark steady-state real interest rate is $r = 4\%$.

[6]The table can be found in this link.

1.4.4 Labor Income

As mentioned above, I calibrate the parameter $\bar{l}$ governing the wedge between hours and earnings jointly with φ to match average hours and the LFP rates. The variance for the permanent ability shock is calibrated to be $\sigma_\theta^2 = 0.349$ in order to target the Gini index of the earnings distribution. The bend points $\{\nu_1, \nu_2\}$ for the returns to experience in the human capital law of motion are taken from the coefficients estimated in the Mincerian regression given by equation (1.20) shown in the Appendix. As the third coefficient of the cubic polynomial is of a small order of magnitude and has a less straightforward economic interpretation, I consider only the first two. The depreciation of human capital is taken from the value estimated in Guvenen, Kuruscu, and Ozkan (2014) and thus set to $\delta_h = 1.5\%$.

If households have kids with age $j^i \in \{0, 1, 2\}$ in the household, they pay childcare cost $\eta = 0.048$ whenever they have positive labor supply. This value is calibrated to target childcare costs standing for 11% of the average household income. The number is taken from the 2018 report "The US and the High Cost of Child Care" released by *Child Care Aware of America*[7] and stands for the average level of the share of earnings paid by married couples based on different methodology of calculations that take into account the main stages of childhood. Finally, the persistence ρ and the error variance σ_ε^2 are the ones obtained by the estimation of the income process from the SIPP 2008. I use the point estimates obtained with the identity matrix as the GMM weighting matrix. The methodology is described in the Appendix and depicted in Table 1.18.

[7] The report can be found in this link.

1.4.5 Government

I follow Holter, Krueger, and Stepanchuk (2019) and choose the fractions $b_G = 7.25\%$ and $b_B = 61.85\%$ such that the value of pure public consumption, G, is equal to two times the military spending and that the outstanding government debt, B, in the model is equal to US's debt-to-GDP ratio.

On the taxation side, I calibrate the capital income tax rate as $\tau_r = 7.4\%$ as in Lopez-Daneri (2016). I set the parameters governing the progressive income tax function as in Holter, Krueger, and Stepanchuk (2019), where they use OECD tax data to find the values for married couples in the US. That yields scale parameter $\tau_0 = 0.9420$ and curvature $\tau_1 = 0.1577$. Finally, the payroll contribution rate of the Social Security system, τ_{SS}, is calibrated endogenously to target areplacement rate $b_{SS} = 36\%$. This is the median rate calculated by the CBO based on either the highest 35 years of earnings or the last 5 years of substantial earnings. It is the number calculated for both sexes and including all quintiles of the earnings distribution[8]. As mentioned previously, the tax on consumption τ_c is the endogenous equilibrium outcome that balances the government budget.

I follow an approach based on Ortigueira and Siassi (2019) and Birinci (2019) to guide the way in which I discipline the choice of relative magnitudes between the parameters, brackets, and transfers sizes based on the transfers code that characterize the IS programs and model units. The whole IS system embedded in the model amounts to 29 parameters. As there are values and references to documentation, I explain it all in detail in Appendix 1.A.3.

[8] More details can be found in the report via this link.

1.4.6 Summary of Calibration

I summarize the information associated with the calibrated parameters in the sequence of tables below. In Table 2.2, one can find the exogenously calibrated parameters and their sources. Table 2.3 shows the endogenously calibrated parameters, the targeted moments associated with each of them, and the source of such moments for their data counterparts. Finally, in another set of tables in the Appendix, I display all the parameters and values used in the model economy's Income Security system. Table 1.19 and 1.20 collects the EITC parameters. In Tables 1.21 and 1.22 one can find the parameters for the remaining IS programs.

Table 1.1: Exogenously calibrated parameters.

	Parameter	**Value**	**Target / Source**
Demographics			
Model's terminal and retirement ages	JJ, J_R	80, 45	Ages 100 and 65
Population growth	n_p	1.1%	Historical data
Survival probabilities	$\{\psi_j\}_{j=1}^{J}$	-	Fehr and F. Kindermann (2018)
Ages children are born	$\{n_i\}_{i=1}^{3}$	27, 30, 33	Exogenous
Fraction of pop. with children	p_k	30%	Bureau of Labor Statistics
Preferences			
Frisch elasticity	γ	1.00	Lopez-Daneri (2016)
Technology			
Capital share	α	0.35	Historical data
Labor Income			
Persistence and variance of AR(1)	$\{\rho, \sigma_\varepsilon^2\}$	0.9342, 0.0176	SIPP 2008
Human capital returns	$\{\nu_1, \nu_2\}$	0.0533, -0.0013	SIPP 2008
Depreciation rate of human capital	δ_h	1.5%	Guvenen, Kuruscu, and Ozkan (2014)
Government			
Public consumption goods, national debt	$\{b_G, b_B\}$	7.25%, 61.85%	Holter, Krueger, and Stepanchuk (2019)
Investment income tax rate	τ_r	7.4%	Lopez-Daneri (2016)
Scale and curvature of income taxes	$\{\tau_0, \tau_1\}$	0.9420, 0.1577	Holter, Krueger, and Stepanchuk (2019)

Table 1.2: Endogenously calibrated parameters.

	Parameter	Value	Target	Source
Preferences				
Discount factor	β	0.982	$K/Y = 2.9$	Fabian Kindermann and Krueger (2018)
Disutility of labor	φ	16.994	$H = 33\%$	Standard
Commuting costs	$\bar{l}$	0.192	LFP = 73.9%	Bureau of Labor Statistics
Labor Income				
Childcare cost	η	0.048	11% of $\bar{y}$	Child Care Aware of America
Variance of permanent shocks	σ_θ^2	0.349	Earn. Gini = 0.44	SIPP 2008
Technology				
K depreciation rate	δ_k	7.8%	$r^* = 4\%$	Standard
Government				
SS Payroll tax	τ_{SS}	10.61%	$b_{SS} = 36\%$	Congressional Budget Office

1.5 The Benchmark Economy

1.5.1 Aggregates

I begin the assessment of the benchmark economy by reporting the equilibrium quantities of the main aggregate variables of the model and comparing them to their counterpart targeted and non-targeted levels in the data. Table 1.3 below summarizes the moments of the benchmark model with the baseline welfare system composed of the means-tested transfers. The model matches closely several of the aggregate levels of interest. The capital-to-ouput ratio, K/Y, the aggregate level of hours worked, H, the equilibrium interest rate, r, and the labor force participation (LFP) are all at their targeted levels. The investment-to-GDP ratio, I/Y, and the consumption-to-GDP ratio, C/Y, were not targeted but are both at levels coherent with the historical US data.

The size of the IS system, captured by the share of the total amount of transfers by the GDP, TR/Y, is approximately double the size of the one calculated by the CBO. Even though the parameters for this system are calibrated to reflect the relative share of their values in our model economy, the risky nature of the environment under incomplete markets endogenously selects households for regions where they can obtain insurance. As there is no other source of direct insurance during the working age besides savings, it is natural that the endogenous outcome would lean towards a reliance on the IS system for this purpose. This is thus reflected in a larger share of the transfer system that was initially exogenously calibrated in the model.

As I target the replacement rate of the SS system, b_{SS}, the payroll tax used to close the system's budget endogenously achieves the rate of 10.61%, which is thus non-targeted and close to the 12.4% rate set by the IRS. A similar pattern applies to the endogenous tax on consumption, τ_c, with the difference that the US does not have such tax at the federal level. Nonetheless, the value obtained of 6.7% is not far from the level estimated in Trabandt and Uhlig (2011), and this rate provides an estimate of the tax burden of the benchmark income security system to provide aggregate level of transfers TR, which is key in the counterfactual comparisons.

Table 1.3: Aggregate variables at the benchmark economy.

Variable	Benchmark	Target / Data	Source
Targeted			
K/Y	290.0%	290%	Standard
H	32.1%	33%	Standard
LFP	74.1.3%	73.9%	BLS
r	0.042	0.040	Standard
Untargeted			
C/Y	64.4%	68%	FRED
I/Y	25.5%	17%	FRED
TR/Y	2.6%	1.3%	CBO
τ_c	6.7%	5%	Trabandt and Uhlig (2011)
τ_{SS}	10.6%	12.4%	IRS

Note: The data counterparts shown in the table are taken from several sources. I use the last available period of FRED St. Louis data for share of personal consumption expenditures over GDP, and gross private domestic investment over GDP. It can be found, respectively, in the following links: here, and here. The CBO data stands for the breakdown of mandatory spending in 2018 and can be found here. The SS withtholding rate is defined by the IRS and can be found here.

1.5.2 Earnings and Wealth Distributions

The evaluation of the model fit is also depends on the comparison of the inequality on labor earnings and wealth in the benchmark economy with the one observed in the data. Table 1.4 below shows such distributional outcomes of the model in comparison with the SIPP 2008 estimates, all of those untargeted moments, except, as mentioned previously, for the Gini coefficient of the labor earnings distribution.

The model is able to closely approximate the earnings distribution, with some relatively small overstatement in the fourth quintiles and understatement of the third quintile. Given that we have estimated the wage process directly from our sample of the SIPP data and exogenously fed into the model this source of earnings risk, such positive result is expected. However, the close fit in terms of magnitude in all quintiles is reassuring that the labor income side of the baseline economy is able to exhibit similar behavior to the data.

A second and more rigorous assesment of the fit can be done by observing the wealth distribution outcomes. As the savings decisions is one of the critical endogenous choices of the agents in the model, their behavior in terms of these choices gives us a more accurate understanding on whether the environment of the benchmark economy captures correctly the mechanism behind such decision in the data. The model is not able to quantify precisely the share of wealth across the quintiles, however, the Gini coefficient is not very far from the one calculated in our sample of the SIPP data.

At very bottom of the wealth distribution, as the model does not allow borrowing, the distribution stops at zero assets. It is not able then to capture the negative value standing for debt, as observed in the data for the first quintile. However, the model is overall able to capture a low level of savings for the first three quintiles, approximating well the distribution computed in the data from other surveys such as the *Survey of Consumer Finances* (SCF) or the *Panel Study of Income Dynamics* (PSID) (Kuhn and Rios-Rull, 2015; Krueger, Mitman, and Perri, 2016a). As the SIPP data for assets is taken from a point in time provided in a topical module, it is reassuring that the model is at least consistent with other data sources[9]. This outcome is mainly possible due to a combination of two model ingredients: the steep profile in earnings generated by the human capital accumulation component and the different levels of assets and investment income testing that the IS system imposes to agents in the economy.

The intuition behind this outcome comes from the fact that households are born with zero assets and then climb up the savings ladder as they receive the idiosyncratic shocks. The shocks are persistent and households that receive low level shocks end up always preferring to choose a smaller level of assets in order to frontload consumption when incentive to work are small. This consumption-savings trade-off is further enhanced by the presence of means-tested transfers. This point is developed again later, when I highlight the distortions induced by the means-testing vis-a-vis the the UBI [10].

[9] I add summary statistics alongside with more details and explanations on the SIPP 2008 panel used in the Appendix 1.A.1

[10] Such low wealth accumulation due to assets means-testing has a similar mechanism to the one pointed in Hubbard, Skinner, and Zeldes (1995) and re-emphasized in Wellschmied (2020).

Table 1.4: Earnings and wealth distribution.

	Earnings		Wealth	
	Data	Model	Data	Model
Quantile				
Bottom 20%	3.7%	4.0%	-0.7%	0.0%
20% - 40%	9.1%	8.8%	1.8%	0.6%
40% - 60%	15.0%	13.6%	7.7%	1.4%
60% - 80%	23.4%	25.0%	20.5%	14.5%
80% - 100%	48.7%	48.5%	70.7%	83.4%
Gini	0.44	0.44	0.70	0.77

Note: The data counterparts shown in the table are all taken from my own calculations from the SIPP 2008 panel. A more detailed description can be found in the Section 1.A.1 of the Appendix.

1.5.3 The Alaska Permanent Fund Dividend

A final step taken towards evaluating the model fit consists of checking whether the predicted behavior of the model economy aggregates are in accordance with the empirical evidence of the effects of unconditional transfers on the labor side of the economy. In order to do so, I will compare the outcomes of the model to some of the estimates of Jones and Marinescu (2018) for the impact of the Alaska Permanent Fund Dividend. As mentioned before, the Alaska's experience is by now the closest we can get in terms of empirical evidence to an understanding of the macroeconomic and general equilibrium impact of unconditional transfers in the US.

The idea behind this validation is to operate the following thought experiment: we start with the economy at the initial steady-state with the means-tested transfer system and then move to a counterfactual economy where all households receive the dividend. The structure of benefits is maintained intact, and thus the dividend is just an addition on top of the currently existing benefits. This extra expenditure in the government's budget constraint is funded by windfall revenues and thus there is no need for the adjustment of taxes to keep the government budget constraint balanced. The size of the transfer distributed to each of the households is the equivalent of US $1,115 in model units, which is the average dividend level from 1982 to 2018[11]. This yields a transfer of 1.9% of the GDP per capita in the model economy.

In the first row of Table 1.5 below, I show the relevant point estimates taken from Jones and Marinescu (2018). The first column shows the difference in the average employment rate between Alaska and their controlled sample. This is the evidence that highlights the adjustment of the extensive margin of labor and shows virtually zero effects with a point estimate of -0.001. In the second column, I move to one of their measures of adjustment at the intensive margin, which is the part-time rate (part-time employment as a share of the population). They estimate an aggregate increase of 1.8 percentage points between treatment and control averages.

In the second and third rows of Table 1.5, I show the differences in model averages between the benchmark and counterfactual economies. Moreover, in order to highlight the role of general equilibrium effects and how the adjustment of aggregate demand and supply of labor in the economy brings the model behavior closer to the data, I report both partal and general equilibrium results.

It is also worth to notice that the results for the part-time rate require a mapping

[11]The table with the historical data of the dividend is provided by the *Alaska Department of Revenue - Permanent Fund Dividend Division* and can be found in this link.

of this definition in terms of the model economy. As in Jones and Marinescu (2018) the main data source is the *Current Population Survey* (CPS), part-time employment is defined as less than 35 hours of work per week. As labor supply in the model is defined in terms of percentage of the unit endowment of time of households, part-time is then approximately the use of 29% or less of their endowment when compared to a full-time work week. Given that the model has the non-convex mapping between hours and earnings defined in equation (1.7), it exhibits a continuous intensive margin that allows for this notion to be well-defined in terms of the model labor supply allocations.

The results in Table 1.5 show that the model is able to replicate the signs and approximate the order of magnitude of the changes in the average employment rate and the average part-time rate. Moreover, the general equilibirum component is crucial for the model not to overstate such changes. In fact, for the employment rate, the availability of windfall transfers for the households dampens their extensive margin, yielding a drop at the employment rate which is attenuated once the general equilibrium effect is added. The decrease in the labor supply is followed by the adjustment in the competitive wage, which increases, thus pushing labor supply to increase back, diminishing the net effect on the employment rate. A similar intuition applies to the movement in the part-time rate. As more transfers are available, households can now operate in their intensive margin, increasing leisure and thus the part-time rate. Given that the price of labor adjusts to this movement, incentives to work more grow, and the part-time rate falls accordingly.

Table 1.5: Estimated differences between treatment and control for Alaska.

	Differences of Averages	
	Employment Rate	**Part-time Rate**
Data	-0.001	0.018
Model - Partial Equilibrium	-0.022	0.007
Model - General Equilibrium	-0.019	0.002

Note: The row for data show the estimates obtained in Jones and Marinescu (2018). The rows for the model shows diferences between model aggregates in the benchmark and counterfactual economies.

1.6 Quantitative Exercises

In this section I outline the results of the quantitative exercises conducted highlighting the impacts on aggregates, life-cycle profiles, and inequality. In section 1.6.1, I discuss the thought experiment behind the expenditure-neutral UBI counterfactual, its results and the mechanism behind the economies with and without means-testing. In section 1.6.2, I then move to a UBI reform with a level of US$12,000 annualy. In sections 1.6.3 and 1.6.4, I discuss, respectively, the impact of both reforms on inequality and the government budget constraint.

1.6.1 Expenditure-neutral UBI

The idea behind the counterfactual towards a UBI reform of the Income Security system is simple: substitute all transfers $T_{TC}[y, d, j]$ and $T_{CT}[y_a, a, j]$ defined in (1.11) and (1.12) with an unconditional payment TR_{UBI}. I hold constant the commitment on spending and debt level, $G = b_G Y$, $B = b_B Y$, and distribute to the households the same aggregate level of total transfers TR computed for the benchmark equilibrium in a per household base. The budget constraint of the household then becomes:

$$\text{if } j < J_r: \ (1+\tau_c)c + a' + \eta \mathbb{1}_{[l>\bar{l}]} = a(1 + r(1-\tau_r))$$

$$+ (1-\tau_{SS})y(l,h,z) - T_l[y(l,h,z)] + TR_{UBI} \tag{1.17}$$

$$\text{if } j \geq J_r: \quad (1+\tau_c)c + a' = a(1 + r(1-\tau_r)) + b(x) + TR_{UBI} \tag{1.18}$$

The government budget balance remains being financed with consumption taxes - i.e., with τ_c endogenously changing - and equation (1.13) holds in the same way with the substitution of TR by TR_{UBI}. These transfers have the same exact numerical value in this expenditure-neutral exercise.

Aggregates

In Table 1.6 below, I summarize the aggregate changes generated by the counterfactual exercise in comparison with the benchmark scenario. With respect to the labor supply response, the impact on aggregate hours is moderate, with the overall level climbing to about 1 percentage point higher than the one in the benchmark. This happens because, in the counterfactual economy, households no longer need to adjust their intensive margin downwards to fall inside the means-testing brackets. The UBI mostly operates via the income effect, shown by the movement at the extensive margin which decreases the labor force participation by one percentage point.

One can also observe the impact of the reform on the budget captured by τ_c, which is now slightly smaller than the benchmark level due to the decrease in TR/Y. I explore this point further and in convolution with the distributional outcomes in the breakdown of the government constraint in 1.6.4. The capital-output ratio is larger in the UBI economy, mainly driven by the increase in savings and yielding higher levels of capital, which then pushes the increase in the output level.

The aggregate stock of human capital in relation to output, HC/Y, decreases by more than ten percentage points due to the decrease in the number of participants in the labor force, without the participation of high productivity households. Following the small levels of movement in L, the impact on labor earnings inequality is negligible while there is a significant decrease on wealth inequality, which mostly stems from an increase of the wealth accrued by all the bottom 4 quintiles with a reduction of the wealth accrued by the very top quintile. This movement happens due to the release of the investment and asset-testing constraints that provided a extra incentive for smaller savings in the benchmark scenario. Together with that, there is a decrease in the accumulation of capital by agents that receive high and persistent labor income shocks. The combination of such movements are then driving the force behind the capital stock increase.

Table 1.6: Comparison of aggregates for the first counterfactual.

Variable	**Means-Tested**	**UBI**
Y	100	104.3
K	100	106.3
L	100	103.2
C	100	104.0
HC	100	101.0
H	32.1%	33.0%
LFP	74.1%	73.2%
K/Y	290.0%	296.6%
C/Y	64.4%	64.1%
L/Y	56.3%	55.8%
HC/Y	401.4%	388.7%
TR/Y	2.5%	2.4%
w	1.153	1.165
r	0.042	0.040
τ_c	6.7%	5.7%
Earnings Gini	0.44	0.44
Wealth Gini	0.77	0.70

Note: The column with name "Means-Tested" shows the results of the benchmark model and the column with label "UBI" shows the results for the counterfactual exercise.

The Mechanism

In order to understand the mechanism behind the movements shown in the aggregate effects, I explore below the sources of distortions arising from the different types of means-testings in the model. I do so for selected parts of the state-space that are chosen to highlight where such testings are more salient.

In Figure 1.1 below, I show the assets' policy function for a 80 years old retired household. At this age, in the original means-tested economy, such household would only be subject to an assets means-testing stemmimg from the SSI. Besides the SS benefits and the households savings, the only other source of income available are the benefits of this program. In the left-hand side graph, one can see how the policy function of the agent becomes flat once it hits the assets-testing constraints.

The intuition behind that is that at certain level of assets, the household prefers to choose to stay exactly at the constraint in order to seize the benefit payed by the program. It has strong incentives to do so, as by choosing to save a smaller amount than it would otherwise for that level of asset, it can increase its current period consumption not only by dissaving, but also by having access to a larger income. On the right-hand graph, this trade-off is made clearer, as in the UBI economy, such distortion does not exist and hence the policy function for assets does not stay constant for such a wide range of the assets' state-space and allows the household to achieve higher values, an expected result of releasing a constraint in the dynamic programming problem. All lines lie below the 45 degree line, showing that this is a dissaving region, consistent with the retirement period of the household.

Figure 1.1: Distortions stemming from assets means-testing in the comparison between the benchmark economy as the first counterfactual UBI scenario.

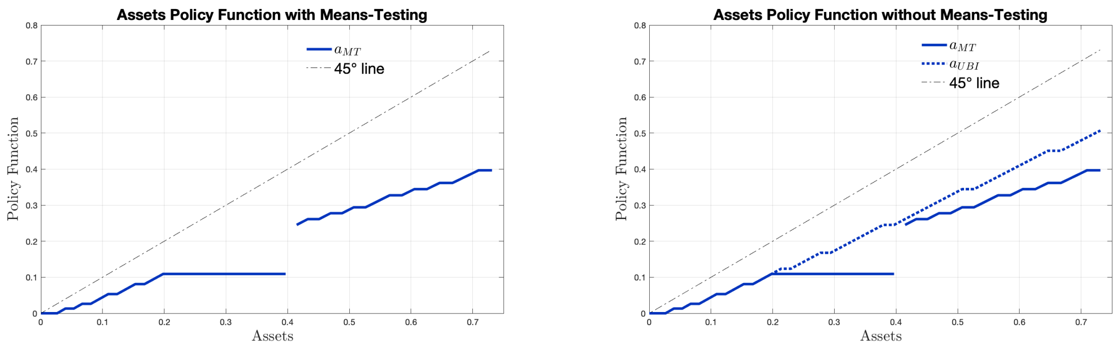
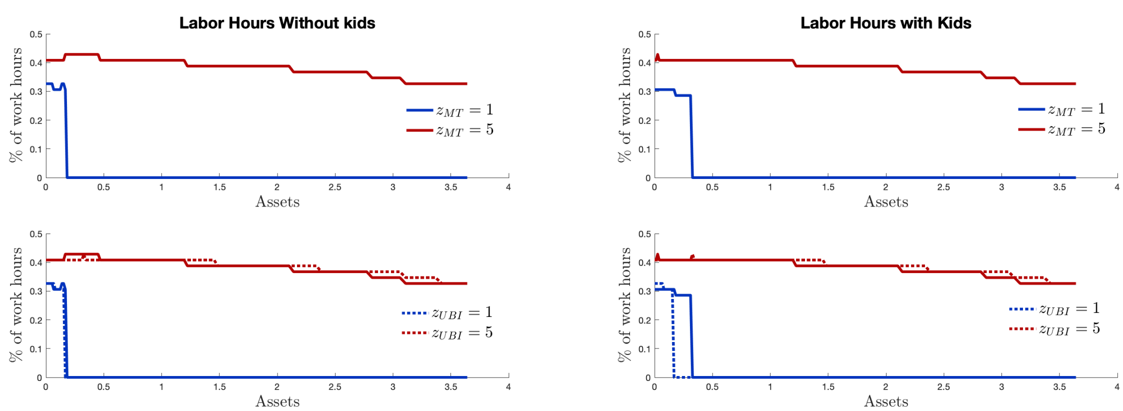


Figure 1.2 portrays the labor supply distortions at low asset holdings and low and high productivity households in the means-tested economy. It zooms in the state-space of a household with 40 years old, and distinguishes on whether it has children or not. On the left-hand side, we can see from top to bottom the differences in labor supply allocations between productivity levels in both economies. Households with low productivity have a double-incentive to work less as not only their marginal cost to supply labor is higher but the means-testing transfers might incentivize them to fall inside the income brackets. As the assets-testing of the EITC is on investment income, hence non-binding for households at the bottom of the wealth distribution, the highest incentive to adjust is on the labor supply margin. Comparing the top and bottom graphs, it is clear that for the smallest level of productivity, there is no significant change in the labor supply of households.

A more perceptible behavior happens with households with high productivity. Even though adjustments are small, one can observe that for high productivity agents, labor supply under the UBI economy is higher for any asset level. This happens because their extensive margin adjustment is unaffected by the design of the transfer system. However, with the extra transfer received unconditionally under the UBI regime, households are not anymore subject to disencentive to work generated by the means-tested transfers.

On the graphs on the right-hand side, we see the difference in behavioral responses for agents with children. For low productivity agents, the reaction to the change in regime of transfer is now different than the one mentioned previously: in the UBI economy, low productivity households are free to work less not being incentivized by the EITC to a highly child-dependent incentive to supply labor. However, for the high productivity households with children, the response now operates in the reverse direction. As the initial means-tested system for them was roughly being accessed via the EITC, the generosity of the money received is then heavily dependent on the presence of children in the household. Hence, households before had the incentive to work at their initial level and obtain sizeable amounts of transfers. In the UBI economy, as it is independent on the number of children for the money received by the household, labor supply has to be higher in higher level of assets.

Figure 1.2: Distortions stemming from earnings and assets means-testing in the comparison between the benchmark economy as the first counterfactual UBI scenario.



1.6.2 Andrew Yang's UBI

The second counterfactual conducted is a non-neutral increase on the the total amount of transfers TR of the economy to the level equivalent to $TR/Y = 20\%$ in the initial steady-state. This exercise is inspired by the policy proposal advocated by Andrew Yang, a candidate to the primaries of the Democratic Party for the presidential election of the United States in 2020[12]. The thought experiment is then to give every agent in the economy a UBI that would amount to US$12,000 per year, or US$1,000 monthly. We proceed in an otherwise identical fashion as the previous counterfactual exercise.

Table 1.7 below shows the results for the aggregate quantities. As expected, the budget cost to raise the level of transfers to the desired level is high and hence the taxation on consumption has to climb up to 38.4% to balance the government's budget. Such high taxation combined with the high level of transfers end up driving agents to react sharply in terms of their labor supply. The intensive margin captured by the aggregate hours decreases substantially, reducing about 15 percentage points. The same sharp drop is seen in the LFP, which now shows that less than a half of the households work in this economy. These large movements in the labor side of the economy are in a great extent driven by the non-convex structure present in the labor supply. With the commuting costs, the aggregate response in labor is amplified due to the larger macro Frisch elasticity that this formulation yields. As the environment is in general equilirbium, there is an accompanying adjustment of the wage rate, which increases by more than 1%. As we have seen in the exercise for the Alaska experiments, this force attenuates the effects on the labor side of the economy, but in the case of this large level of transfers, the rise in the return to labor is not enough to prevent the large drop observed.

[12]Andrew Yang's "Freedom Dividend" policy proposal can be found on this link.

The overall result is that the economy contracts significantly and becomes much more unequal in terms of pre-tax labor earnings. However, both the capital-to-ouput and the consumption-to-output ratios increase due to the fact that the output decreases relatively more than K and C. Lastly, the total stock of human capital in the economy HC, exhibits a substantial decrease when compared to the former steady-states, but a higher value in terms of GDP whe compared with the former counterfactual . This result stems from a selection effect operating behind the extensive margin: low productivity agents sort themselves into zero labor supply due to the generous consumption floor created by the UBI while high productivity agents remain attached to the labor force throughout their life-cycle with virtually no depreciation of their individual human capital. The rearrangement towards inequality shown by the Gini is then a byproduct of such process and happens directly through the accrual of more earnings at the top that arise through the sharp drop in labor of low productivity households. This result is further seen in Table 1.8.

Table 1.7: Comparison of aggregates for the second counterfactual.

Variable	**Means-Tested**	**UBI**	**UBI AY**
Y	100	104.3	74.1
K	100	106.3	75.8
L	100	103.2	73.3
C	100	104.0	77.5
HC	100	101.0	74.5
H	32.1%	33.0%	18.2%
LFP	74.1%	73.2%	42.3%
K/Y	290.0%	296.6%	296.3%
C/Y	64.4%	64.1%	67.2%
L/Y	56.3%	55.8%	55.7%
HC/Y	401.4%	388.7%	403.1%
TR/Y	2.5%	2.4%	26.9%
w	1.153	1.165	1.166
r	0.042	0.040	0.040
τ_c	6.7%	5.7%	38.4%
Earnings Gini	0.44	0.44	0.62
Wealth Gini	0.77	0.70	0.76

Note: The column with name "Means-Tested" shows the results of the benchmark model, the column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

1.6.3 Impact on Inequality

Table 1.8 shows the distributional outcomes of disposable income and consumption for the benchmark means-tested model and the two scenarios under the UBI counterfactual. We can observe that the expenditure-neutral UBI is slightly more redistributive after tax and transfers than the benchmark model. More specifically, the bottom quintile exhibits a small growth in accrued income under the UBI, which arises as a reshuffling from income from the second quintile. The small UBI is not uniformly progressive as the second highest quintile also obtain more post-tax income, mostly coming through their increase in savings. The second UBI counterfactual exhibits a different pattern but with slightly more disposable income at the very bottom but a sharp redistribution towards the highest quintile. This happens due to the suppresision of earnings caused by the large drop in the labor supply, which keeps only the highly productive working. It is noteworthy that pre-tax inequality increases in both counterfactuals as shown in Table 1.7 but post-tax inequality increases in a smaller level with some redistribution towards the very bottom.

Regarding consumption inequality, the first UBI economy is less equal with a redistribution from the bottom two quintiles to the the two immediate upward quintiles, while the second UBI economy exhibits similar inequality to the benchmark and less than the first counterfactual economy with a cascading effect coming from the top quintile towards the immediate two bottom quintiles.

Table 1.8: Comparison of quantiles between benchmark and counterfactuals.

	Disposable Income			**Consumption**		
	MT	UBI	UBI AY	MT	UBI	UBI AY
Quantile						
Bottom 20%	1.2%	1.5%	2.7%	7.7%	7.5%	5.4%
20% - 40%	6.8%	6.6%	3.1%	11.0%	11.8%	9.5%
40% - 60%	12.3%	12.8%	7.6%	16.4%	17.2%	16.7%
60% - 80%	23.4%	24.1%	24.6%	24.7%	24.4%	27.0%
80% - 100%	56.2%	55.0%	61.9%	40.1%	39.0%	41.3%
Gini	0.53	0.52	0.59	0.33	0.31	0.37

Note: The column with name "Means-Tested" shows the results of the benchmark model, the column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

1.6.4 The Government Budget Constraint

In light of all the movements shown previously, it is worth to take a deeper look at how the transmision of inequality affects the aggregate outcomes. More specifically, one highly affected equilibrium object is the government budget constraint. In Table 1.9, I show the breakdown of the budget by each of its sources and for each of the three steady-states analyzed so far.

As can be seen in Table 1.6, the tax rate on consumption, τ_c, decreases moderately in the first counterfactual. This result is intuitive as all the aggregate inputs which suffer the incidence of taxation increase in comparison with the benchmark economy. In the breakdown below, the net negative revenue stemming from the progressive taxation on labor is slightly higher, in terms of GDP, than in the benchmark. The revenue accruing from savings is basically unchanged. This small adjustment which induces less spending in subsidies for the government accomodates the needs of resourcing from consumption, allowing for the drop in the rate.

For the second counterfactual, the increase in the consumption tax revenue can be understood together with the movements shown in Table 1.7. Naturally, as a substantially higher level of TR/Y needs now to be financed, τ_c increases sharply. However, as low productivity households drop of out of the labor force, while the high productivity ones keep working, total labor input L/Y does not fall as much when compared to the first counterfactual while aggregate human capital HC/Y per GDP exhibits a small increase. This is consonance with the higher degree of inequality shown in the pre-tax earnings Gini. With this new distribution, the endogenous outcomes allow for total revenue stemming from progressive taxation TL/Y to be now positive and at a higher level in the breakdown of the budget than in previous steady-states, which attenuates the increase in consumption revenue needed to fund the large UBI.

Table 1.9: Comparison of sources of revenue between benchmark and counterfactuals.

Variable	**Means-Tested**	**UBI**	**UBI AY**
Revenues			
$\tau_c C/Y$	6.7%	5.7%	25.8%
$\tau_r rA/Y$	1.1%	1.1%	1.1%
TL/Y	-1.1%	-0.4%	3.9%
Q/Y	5.1%	5.1%	5.2%
Revenue/Y	11.8%	11.5%	36.0%
Expenditures			
TR/Y	2.6%	2.4%	26.9%
G/Y	7.2%	7.2%	7.2%
$(r - g_n)B/Y$	2.0%	1.9%	1.9%
Expenditure/Y	11.8%	11.5%	36.0%

Note: The column with name "Means-Tested" shows the results of the benchmark model, the column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

1.7 Transitional Dynamics

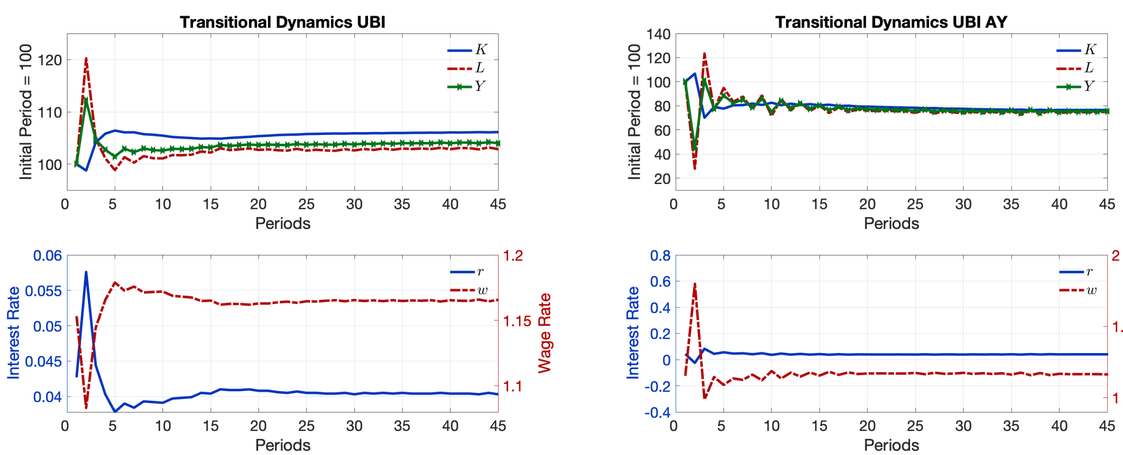
The exercise conducted in the transitional dynamics consists of starting at the initial steady-state at period $t = 0$ and, at period $t = 1$, enact the counterfactual reform. The policy is permanent and unexpected by the agents. The generations $j = 1, \ldots, J$

that were alive in period $t = 0$ will reoptimize to adapt themselves to the new scenario and prices at the capital and labor markets adjust along the transtion path clearing all markets in the economy. The adjustment to the new steady-state is close to achieved in 45 periods, which I use as the maximum due to computational purposes.

1.7.1 Aggregates

Figure 1.3 below depicts the transitional dynamics of the main aggregate variables and of prices after an the enaction of each of the UBI counterfactual reforms. The left-hand side shows the expenditure-neutral UBI, while the right-hand side shows the generous UBI.

Figure 1.3: Transitional dynamics of aggregate variables for the two counterfactual exercises.



When the first reform is enacted, agents immediately and largely adjust their labor supply decisions due to the loss of the generous means-tested transfers to a low level of UBI. This reaction can be observed by the spike in the aggregate labor L which achieves a level 20% higher than the one of the initial steady-state. Moreover, there is also the trade-off between consumption and savings which can be seen in the decrease of aggregate capital K. The drop in capital at the initial period is nonetheless much smaller relative to the jump in labor, only starting to increase to the higher levels of the new steady-state 3 years after the reform. At the final periods, one can observe that the equilibrium trades the initial movement of the labor supply for the increase in savings, then achieving the aggregates in the new steady-state, all higher than their initial levels. The adjustment in prices simply follows the behavior expected from the decreasing marginal returns of the neoclassical production function.

There is a symmetric initial response of the aggregate variables and prices between counterfactuals. The second reform, the one of Andrew Yang's level of UBI, yields precisely the opposite signs of change in the aggregates. With the new and and unexpected large transfer, agents drop out of the labor force and work significantly less, thus reducing L by more than 60%, which then later settles to its lower level. The extra income combined with the exclusion of assets-testing causes a small increase in the level of K, which later converges to the smaller level in the new-steady-state due to the decrease of precautionary savings and hours worked allowed by the UBI's consumption floor. An important fact observed in the transition of this counterfactual is that due to non-convex commuting costs associated with the labor supply, the adjustment in labor is heavily volatile and non-linear, yielding the oscillatory movements seen until convergence. This movements of labor drive the fluctuations of output along the transition[13].

[13] At this point, the convergence of this counterfactual is unstable and lacks precision, which I am currently working in the betterment.

1.7.2 Inequality at the Transition

In Table 1.10, I show the distributions of disposable income and consumption at the first period of the transition. The inequality when the reform is enacted highlights the differences between short and long run that drive the welfare results explained in the next section. When compared to Table 1.8, one can immediately notice that for the second counterfactual, the generous UBI, there are significant differences in the results of all of distributions shown. The most important movement is the redistribution in the consumption distribution when compared to the benchmark steady-state . There is an increase in all bottom three quintiles at the expense of a decrease of the top two quintiles.

For the first exercise, however, there are amplifications in the increase of inequality in consumption. Differently than in the long run, there is less consumption being accrued at the bottom and significantly more at the top. The intuition behind this lies on the fact that for the low strand of the distribution, the amount of transfers received is smaller than before while for the top earners, their return to work is high enough for their labor behavior to be positively affected, allowing for more consumption together with the UBI top-off. The Gini index of the consumption distribution is in this case 2 points higher than the benchmark and 4 points higher than its equivalent in the steady-state, reflecting the shift of accrual towards the top.

Table 1.10: Comparison of quantiles between benchmark and counterfactuals at the transition.

	Disposable Income			**Consumption**		
	MT	UBI	UBI AY	MT	UBI	UBI AY
Quantile						
Bottom 20%	1.2%	2.6%	1.8%	7.7%	6.6%	8.8%
20% - 40%	6.8%	7.5%	4.9%	11.0%	11.0%	11.7%
40% - 60%	12.3%	13.6%	13.3%	16.4%	16.0%	16.9%
60% - 80%	56.2%	23.4%	24.9%	24.7%	23.8%	23.4%
80% - 100%	48.2%	52.8%	54.9%	40.1%	42.5%	39.2%
Gini	0.53	0.49	0.53	0.33	0.35	0.30

Note: The column with name "Means-Tested" shows the results of the benchmark model, the column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

1.8 Welfare

In this section I conduct an evaluation of both reforms through an analysis of the welfare responses in the short and long run. The context for the welfare analysis is an inquiry on whether or not to means-test the income security net of the government based on the computation of a chosen measure of social welfare. Given the initial conditions, I follow Conesa, Kitao, and Krueger (2008) and define the utilitarian Social Welfare Function (SWF) for a newborn agent as follows:

$$W(\{\tau\}, \zeta, TR) = \int_S v^*(a = 0, h = 1, z = \bar{z}, k, \theta, j = 1 \,|\, \{\tau\}, \zeta, TR)\, d\Phi^* \qquad (1.19)$$

where $\{\tau\}$ are all the taxation parameters, ζ is the collection of means-testing parameters, $\zeta = \{\bar{y}^k_{TC}, \bar{d}_{TC}, \ldots\}$, TR is the aggregate level of total transfers, and $\{v^*, \Phi^*\}$ are the equilibrium value functions and distributions.

In Table 1.11 below, I show results for welfare evaluation through the comparison of the three steady-states studied so far as well as the transition between the benchmark and each of the counterfactuals. I report the aggregate steady-state welfare for households with age $j = 1$, i.e., the discounted expected value of being born in each economy through the *Consumption Equivalent Variation* (CEV). This measure defines the increment in consumption that we would need to give households in each state of the world so that they would be indifferent between their level of consumption in the alternative economies, hence *under the veil of ignorance*[14].

Table 1.11: Comparison of Consumption Equivalent Variation.

	UBI	**UBI AY**
CEV Steady-state	-0.05%	-0.04%
CEV Transition	-0.24%	1.22%
Votes	73.13%	80.46%

Note: The column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

[14] I present the algebra and details on how to obtain the CEV for the model in Appendix 1.A.5.

The CEV required is of -0.24%, making the expenditure-neutral UBI a policy that reduces welfare under an utilitarian SWF. The opposite is true for the US$1,000 UBI, with an increase of 1.22% in welfare. If we take into account the welfare cost at the transition, - i.e. the cost to the generations that were alive in the period the reform is enacted and whose choice need to be reoptimized - we observe that the effects of both reforms is flipped. The intuition behind this movement lies on the distributional consequences seen before. We have seen in Table 1.10 that inequality in consumption is higher than in the steady-state, with the disutility of work affecting more the top, and the dampening of consumption the bottom. Lastly, at the period when the reform is enacted, if we could subject the proposal to a voting by the generations alive in that year it would be implemented, it would receive a sound majority in the second scenario, but also a majority in the first, despite the decrease in welfare. The following section unpacks the forces behind such votes.

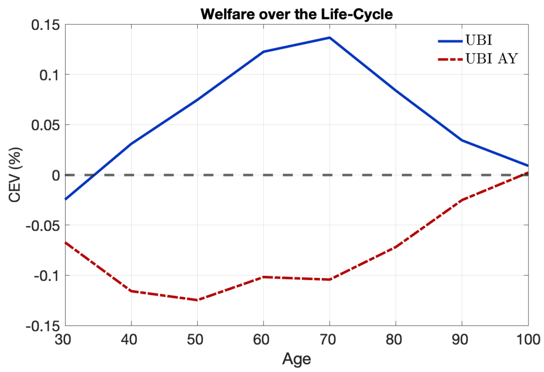
1.8.1 Decomposing the Welfare Effects

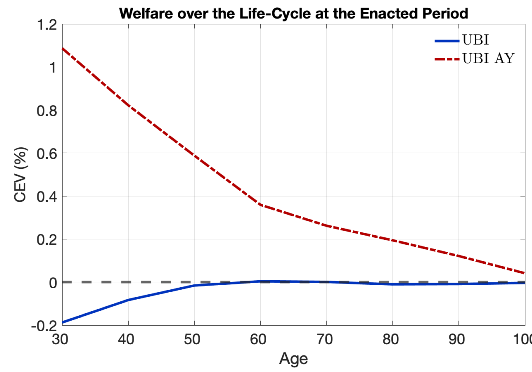
In order to understand better who are the winners and losers of both reforms, it is useful to decompose the welfare changes in different cuts of the state-space. To get a better sense of the role of the age dimension, I plot below the cross-sectional average of the value function over the life-cycle, which can be equivalently defined as an age-dependent SWF in terms of CEV. I do so by showing the average between decades of households' lives. Figure 1.4, shows the comparison between the two counterfactuals both at their steady-states and at the enacted period of the reform.

We can observe in the plot on the left-hand side that the expenditure neutral system exhibits negative levels of welfare than the benchmark scenario throughout the life-cycle, with lower levels at the beginning. As households have children in early ages and the targeted transfers generosity is biased towards families with children, it is natural that a transfer with an average level lower than before leaves agents worse-off in that period of their lives. However, as soon as households start seizing the increasing path of their earnings profile, the savings they accumulate under the new UBI regime decreases the dominance of negative welfare. In effect, households in the benchmark economy at those periods are trapped working less effective hours and saving less to remain inside the constraints that guarantees the reception of the benefits. Eventually, in later ages, after the dissaving process is exhausted in each economy, welfare of both converges to similar levels. During the transition, the losses are larger and for a larger number of years in households' lives. The age dimension also helps us to unveil the source behind the votes shown in Table 1.11, as their percentage in favor of the reform tracks closely the relative share of ages that have welfare below the benchmark scenario.

Regarding the second counterfactual, in the long run, the welfare is slightly negative for the very first ages, being then almost zero for a long part of the working years almost all the way through retirement. Without the breakdown through the life-cycle, this effect is masked by the comparison only of newborn households. An important part of the positive welfare changes only happens closer to retirement, mostly due to the abence of the assets means-testing of the SSI, a fact common in all profiles in all comparisons. At the enacted period of the transition, on the other hand, the gains are uniformly positive across all ages of the cross-section. This once again emphasizes the benefits of simultaneously working less while seizing a high consumption floor in an economy that starts with a large amount of capital that slowly decreases. The voting pattern of more than 80% in favor is thus a natural consequence of this picture.

Figure 1.4: Value functions over the life-cycle between steady-states and at the period when the reforms are enacted.





Another important dimension of decomposition is the permanent ability level of the households. The value θ is the only source of labor income heterogeneity of households' initial conditions and directly tracks the overall level of earnings inequality captured by the Gini index. In Table 1.12, one can observe the breakdown for the two points in which I discretize this shock. Given the way that wage risk was estimated, this points can be roughly interpreted as a comparison of college and non-college levels of initial ability. The results for the steady-states show that there is an inverse pattern between the two counterfactuals. In the small UBI economy, low ability households are worse-off due to the expected lack of generosity of the income security system in the first ages of their lives. High ability households, on the other hand, will mostly probably be attached to the labor force with high efficiency units and thus have small but positive welfare stemming from the unconditional transfers. In the second counterfactual, the direction is opposite, as high ability agents will mostly likely be the ones suffering the hike in taxation needed to sustain the reform, they benefit little from the new policy. Low ability households, on the other hand, anticipate the abundance of leisure and consumption in relative terms and accrue a substantial part of the gains.

Table 1.12: Decomposition of Consumption Equivalent Variation.

CEV	**UBI**	**UBI AY**
Steady-State	-0.05%	-0.04%
Initial Heterogeneity		
Low ability	-0.0823%	0.0106%
High ability	0.0328%	-0.0517%

Note: The column with label "UBI" shows the results for the expenditure-neutral counterfactual and the column with name "UBI AY" shows the results for the exercise inspired by Andrew Yang's proposal.

1.9 Conclusion

In this paper, I addressed the question on what would be the impact of a nation-wide reform of the U.S. welfare system to a Universal Basic Income proposal. I have developed an overlapping generations model with idiosyncratic income risk that incorporates both intensive and extensive margins of labor supply, human capital accumulation through labor market experience, and child-bearing costs. The model has a welfare system with an income security net that matches the U.S. design and accounts for means-testing requirements in income and wealth and its taxation counterparts. The focus of my analysis lied in the changes in aggregates. inequality, government budget, and welfare.

I calibrated the model to the U.S. and conducted two counterfactual exercises implementing UBI reforms. In the first reform, an expenditure-neutral level of unconditional transfers generates an income effect that lead households in the UBI economy to work more hours and decrease the participation in the labor force. Due to the absence of restrictions on maximum level of assets, households save more and aggregate capital increases, followed by an increase in output of 4.3%. I have not found a large impact on revenue requirement, as the endogenous tax rate on consumption decreases by one percentage point to sustain such reform.

In my second counterfactual exercise, I implement Andrew Yang's proposal of UBI. I let the level of transfers be of US$12,000 annualy to each agent in the economy. In this scenario the tax rate on consumption needs to increase 32 percentage points in order to balance the government's budget. The aggregate response of the economy is a contraction of both capital and output. The second UBI reform increases the Gini coefficient for pre-tax earnings mostly due to the selection mechanism arising from the high productivity agents that remain in the labor force and are able to buffer consumption through higher level of savings. There is some redistribution in both counterfactuals towards the bottom 20%, driven by a reduction of the means accrued by the middle-class. At the transition the small UBI transfer reduces consumption inequality whereas the large-scale program significantly redistributes consumption acrual from the top to bottom quintiles.

The welfare system under the expenditure-neutral UBI yields a welfare loss of -0.24% in Consumption Equivalent Variation relative to the initial means-tested welfare system. The UBI economy achieves a lower welfare than the current IS system in early ages when households have children but then exhibits a higher welfare in later ages and a lower variance of consumption during the retirement years. Alternatively, the generous UBI transfer improves welfare in 1.22%, exhibiting gains for all decade averages of households alive during the transition.

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1.A Appendix

1.A.1 Data - SIPP 2008

In this section I outline the empirical evidence obtained from the the 2008 panel of the *Survey of Income and Program Participation* (SIPP). The SIPP is a representative sample of the civilian United States population and provides information on earnings, transfers from different U.S. income security programs, a fine breakdown of households' balance sheet and detailed demographics which are used in the calibration of the model for the U.S. economy. The SIPP is the natural candidate of household survey data for this paper's question as it has detailed questions for many of the programs designed to target this stratum of the population.

The 2008 panel consists of 16 waves for which interviews are conducted every 4 months. The sample selection used spans through May 2008 to December 2013, and is observed monthly. I deflate all values with the CPI for the last month in my sample and restrict the observations units to be at the household level in which the head of the household age is between 20 and 65. In the SIPP, I use the classification *reference person* to follows observation units. I guide the empirical documentation following a methodology similar to the one used in Kaplan, Violante, and Weidner (2014) and Kuhn and Rios-Rull (2015), in which authors characterize several measures of inequality in different household survey datasets. In particular, I construct equivalent definitions of Net Iliquid and Net Liquid Wealth from Kaplan, Violante, and Weidner (2014) for the SIPP questionnaire. The data for assets is taken from the Topical Modules of the 2008 Panel. I cross-check with their estimates and find similar qualitative patterns and orders of magnitude.

Summary Statistics

The Table 1.13 below displays the summary statistics for my sample:

Table 1.13: Sumarry statistics. Source: SIPP 2008

Variable	Mean	Std. Dev.	Min	Max
Earnings	5,952.1	5,855.7	1.0	137,984.6
Income	6,698.3	5,964.5	-5,163.9	139,644.9
Cash Transfers	36.4	206.5	0.00	5,239.1
Net worth	242,136.7	806,620.6	-729,020.1	1,903,800
Net liquid wealth	193,187.4	269,582.1	-453,567.4	2,427,526
Checking accounts	133.0	688.5	0.00	8,099.4
Bonds	260.6	2,067.8	0.00	32,397.8
Credit cards	907.7	2,650.8	0.00	16,198.9
Loans	747.5	7,041.0	0.00	125,000.0
Debt	759.6	4,324.7	0.00	48,596.74

Tables 1.14 and 1.15 below characterize the percentiles partition for the distribution of several statistics.

Table 1.14: Distribution for the SIPP 2008 panel.

Percentiles	1	5	10	25	50
Earnings	195.3	695.6	1,177.6	2,334.6	4,439.4
Income	517.9	1,287.7	1,796.8	3,054.9	5,192.1
Net worth	-70,007.4	-2,809.9	159.7	10,579.1	90,092.4
Net liquid wealth	-45,000.0	-12,912.3	-5,399.6	-186.3	0.0
Net illiquid wealth	-75,054.9	0.0	0.00	0.00	91,557.3

Table 1.15: Distribution for the SIPP 2008 panel (continued).

Percentiles	75	90	95	99	Gini
Earnings	7,736.7	11,927.6	15,428.5	32,886.0	0.44
Income	8,510.2	11,2731.5	16,300.4	33,486.1	0.43
Net worth	302,189.8	651,205.9	964,770.5	185,131,1	0.70
Net liquid wealth	0.0	77.4	917.9	7,984.6	–
Net illiquid wealth	276,461.4	548,279.5	761,348.9	1,208,344	0.70

Table 1.16 below displays the correlations between the statistics calculated.

Table 1.16: Joint distribution for the SIPP 2008 panel.

	Earnings	Income	Net worth	Liq. wealth	Illiq. wealth	Transfers
Earings	1.00					
Income	0.9874	1.00				
Worth	0.4027	0.4344	1.00			
Liq. wealth	-0.0889	-0.0849	-0.0086	1.00		
Illiq. wealth	0.4057	0.4373	0.9994	-0.0263	1.00	
Transfers	-0.0837	-0.0390	-0.0575	0.0139	-0.0580	1.00

1.A.2 Estimation of the Wage Process

I annualize the monthly data on labor earnings from the SIPP 2008 in order to estimate the idiosyncratic income risk present in the model. I run the regression on log wages in equation (1.20) below and obtain the income residuals used in the GMM estimation.

$$\log W_{ijt} = c + \mathbf{D}_t + \mathbf{E}_{ijt} + \nu' \mathbf{A}_{ijt} + w_{ijt} \tag{1.20}$$

where i stands for household, W_{ijt} are wages obtained dividing earnings by hours worked, c is a regression constant, $\mathbf{D}_t$ are time dummies for the years of observation 2008-2013, $\mathbf{E}_{ijt}$ are dummies that control for two levels of schooling - less or equal than high school college degree and some college or above degree -, and $\mathbf{A}_{ijt}$ stands for a cubic polynomial on years of potential labor market experience, which are tied to age. Table 1.17 shows the result for the Mincerian regression.

Table 1.17: Regression results for equation (1.20).

Dependent Variables	$\log W_{ijt}$
D_{2009}	-0.0159***
	(0.00177)
D_{2010}	-0.0318***
	(0.00192)
D_{2011}	-0.0523***
	(0.00208)
D_{2012}	-0.0473***
	(0.00226)
D_{2013}	-0.0416***
	(0.00260)
E_2	0.221***
	(0.00519)
ν_1	0.0535***
	(0.00151)
ν_2	-0.00138***
	(7.02e-05)
ν_3	9.54e-06***
	(9.88e-07)
Constant	1.273***
	(0.0112)
Observations	1,161,201
Number of Households	34,653

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Following Heathcote, Storesletten, and Violante (2010), I assume stationarity and postulate that the log residuals follow a process with persistent and transitory shocks, z and η, respectively:

$$w_{i,j} = \eta_{i,j} + z_{i,j},\ \ \eta_{i,j} \sim N(0, \sigma_{\eta}^2),\ \ z_{i0} \sim N(0, \sigma_{z_0}^2) \tag{1.21}$$

$$z_{i,j+1} = \rho z_{i,j} + \varepsilon_{i,j},\ \ \varepsilon_{i,j} \sim N(0, \sigma_{\varepsilon}^2) \tag{1.22}$$

The parameters from this process can be identified in levels by the theoretical moments. More precisely, ρ is identified by the slope of the autocovariance of z at lags greater than 0; σ_{ε}^2 and σ_{η}^2 are both identified by the difference between variance and autocovariance of u, and $\sigma_{z_0}^2$ can be obtained residually from $var(z_{i,0})$.

I drop households with non-positive earnings ending with a sample of 1.2 mm observations with which I conduct an over-identified GMM estimation using the identity matrix, as the weighting matrix Ω[15]. Table 1.18 below shows the obtained estimates.

Table 1.18: Estimation of the income process.

Ω	$\hat{\rho}$	$\hat{\sigma}_{\varepsilon}^2$	$\hat{\sigma}_{\eta}^2$	$\hat{\sigma}_{z_0}^2$
Identity	0.9342	0.0176	0.3595	0.3975

1.A.3 Calibration of Means-Tested Programs

The model uses three different types of means-tested transfers with parameters that require mapping to the data: the EITC, the SNAP/TANF, and the SSI. I will explain

[15]The suggestion can be found in Guvenen (2009), that uses this matrix as it a standard in the literature for small sample estimations.

in detail how I proceed for each parameter of each program.

The requirements for the EITC are defined by the IRS. First, there are the *Earned Income* limits that allow households to be eligible for the program. In the model they are defined by the variable $\bar{y}^{k}_{TC}$, which depends on the number of children present in the household $n_{k,j}$. I define these quantities in terms of model units as shares of GDP per households. As households have unit mass, this simply means shares of the final good Y. For example, the total *Earned Income* limit in 2019 for a taxpayer filing as a head of household with one child is US$41,094. Assuming a GDP per capita in the U.S. of $60,000, this yields 25.95% of GDP. In the model then, I define $\bar{y}^{n_{k,j}=2}_{TC} = 0.26 * Y$. As in the simulated economy there is no notion of marriage and the data used in the SIPP is based on a sample in which the observation unit is characterized by the *reference person*, I use the data for taxpayers filing as head of household in the case of the EITC. An analogous procedure is then used for the subsequent thresholds depending on the number of children.

The limit on *investment income*, $\bar{d}_{TC}$, is, as of 2019, is US$3,600 and independent on the number of children in the household. For this parameter, my preferred choice of mapping is in relation to average assets per capita, A. As I will use a similar calculation for the assets-testing of the other programs, I will map them to the mean *Equity in 401k and Thrift savings accounts* calculated for my sample of the SIPP data. The limit is then exactly 9.81% of this value. As A is an endogenous variable in the model and it is more tractable to define the threshold on assets exogenously, I solve the model several times and set a value that with some certainty lies close to the one calculated for the threshold in the data. At the final steady-state for the benchmark economy, the restriciton on assets for the EITC is approximately 9% of average assets. Table 1.19 below collects all the aforementioned parameters.

Table 1.19: EITC parameters.

# Children	$\bar{d}_{TC}$	Target	$\bar{y}_{TC}$	Target
$n_{k,j} = 0$	0.18	$\approx$ 9% of A	0.13	$\approx$ 26% of Y
$n_{k,j} = 1$	0.18		0.36	$\approx$ 69% of Y
$n_{k,j} = 2$	0.18		0.45	$\approx$ 87% of Y
$n_{k,j} = 3$	0.18		0.48	$\approx$ 93% of Y

The phase-in and phase-out rates κ_1 and κ_2 are independent of units and are thus taken exactly as the ones defined by the IRS for 2019. The phase-in level $\underline{y}$ multiplied by the phase-in rate yields the maximum credit amount at each child level. For example, for a taxpayer filing as a household with no children, the maximum credit is US\$529 per year and $\underline{y}^{n_{k,j}=0}$ is US\$6,920, which is approximate 11% of GDP per capita. Both the phase-in and phase-out levels are similarly defined in terms of percentages of Y[16]. Table 1.20 collects all remaining details of the parametrization of the EITC.

Table 1.20: EITC parameters (continued).

# Children	κ_1	κ_2	Target	$\underline{y}$	Target	$\bar{y}$	Target
$n_{k,j} = 0$	0.0765	0.0765	IRS	0.06	$\approx$ 11% of Y	0.07	$\approx$ 14% of Y
$n_{k,j} = 1$	0.3400	0.1590		0.8	$\approx$ 16% of Y	0.15	$\approx$ 30% of Y
$n_{k,j} = 2$	0.4000	0.2100		0.12	$\approx$ 24% of Y	0.16	$\approx$ 32% of Y
$n_{k,j} = 3$	0.4510	0.2100		0.12	$\approx$ 24% of Y	0.16	$\approx$ 32% of Y

[16] All details regarding the numbers and limits here used can be found at this IRS link and at this link from the *Center on Budget and Policy Priorities*.

The cash transfers parameters are defined in a similar fashion. First, it is important to notice that recently there has been a change in the requirements of assets limits for SNAP and TANF. By 2018, 37 states abolished the test for food stamps and eight for the TANF (Wellschmied, 2020). As I am bundling both programs together, I keep the assets means-testing with the constraint $\bar{d}_{CT}$. In the tax code this test is made on households' *resources* which vary by program. I will keep the mapping with the 401k accounts used before for the EITC. Currently, for SNAP, the *U.S. Department of Agriculture* (USDA) defines a maximum of US \$2,250 in countable resources or US\$3,500 if at least one member of the household is of age 60 or older. A recent study by the *PEW Charitable Trusts* identifies that more than half of the States in the U.S. use a threshold between US\$1,000 and US\$2,500. I choose US\$2,500 which is 7% of the average equity in the SIPP sample and proceed in the same way of the EITC to map it to about 7% of A in the benchmark economy[17].

For the income limit $\bar{y}_{CT}$, I use the value defined by the USDA for maximum gross income for a household of size 2. This maps in the model to about 40% of Y. I proceed in the same way for the annual benefit t_{SNAP}. The USDA defines a monthly benefit of US\$355, which compounds annualy to approximately 7% of the GDP per capita. Table 1.21 below summarizes the information for the SNAP/TANF transfers.

Table 1.21: Cash transfers parameters.

Test	$\bar{d}_{CT}$	Target	$\bar{y}_{CT}$	Target	t_{SNAP}	Target
Value	0.12	$\approx$ 7% of A	0.20	$\approx$ 40% of Y	0.03	$\approx$ 7% of Y

[17] The website of the USDA that defines all criteria for SNAP from 2019 to 2020 can be found in the following link. The website with the PEW study about limits on family assets in the context of the TANF can be found in this link.

Finally, the only remaining program is the SSI, which in the model environment is only attainable during retirement. The SSI is tested only on *resources*, which in this case do not count households' house or vehicles. The maximum defined by the *Social Security* is US$2,000 for an individual and US$3,000 for a couple. I map that as approximately 6% of A. The monthly benefit rate defined by the SS is US$771 for an individual and US$1,157 for a couple. However, the SSI benefit suffers deductions if the household receives SS pensions. In the model all retired households receive a benefit $b(x_t)$ equal to 36% of the average income of the simulated economy, which amounts to the equivalent of US$2,160 monthly. If I were to follow directly the deduction schedule, households would not receive any SSI benefits. As a compromise, I set t_{SSI} as 1% of Y, yielding a monthly transfer of US$65[18]. Table 1.22 below shows all values used for the SSI.

Table 1.22: SSI parameters.

Test	$\bar{d}_{SSI}$	Target	t_{SSI}	Target
Value	0.110	$\approx$ 6% of A	0.006	$\approx$ 1.3% of Y

1.A.4 Stationary Recursive Competitive Equilibrium

Definition 2 (Stationary Recursive Competitive Equilibrium)**.** *A stationary recursive competitive equilibrium with population growth for this economy is an allocation of value functions* $\{v(s), v^R(s)\}$*, policy functions, prices* $\{w, r\}$*, an age-dependent but time-invariant measure of agents* Φ*, transfers and taxes such that:*

[18] The website of the SS for the *resources* criteria for the SSI can be found via this link. For the rules regarding the benefit rates one can go to this link .

1. *The value functions* $\{v(s), v^R(s)\}$ *and policy functions* $\{a'(s), c(s), l(s)\}$ *solve the households' optimization problems (1.14) and (1.15), given the factor prices and initial conditions;*

2. *The individual and aggregate behaviours are consistent:*

$$G = g_y Y, \;\; B = g_b Y$$

$$(1+g_n)K = \int_S a'(s) d\Phi - (1+g_n)B$$

$$C = \int_S c(s) d\Phi$$

$$L = \int_S \exp(\theta + z_j) h(s) \ell(l(s)) d\Phi \left(s_{-j}, \{1, \ldots, J_R - 1\}\right)$$

3. $\{r, w\}$ *are such that they satisfy the firm's first-order conditions (2.5) and (2.6);*

4. *The final good market clears:*

$$C + (g_n + \delta_k)K + G + CC = AK^\alpha L^{1-\alpha}$$

5. *The Government balances its budget:*

$$G + \int_S \left[T_{TC}(s) + T_{CT}(s)\right] d\Phi + (r - g_n)B =$$
$$\int_S \left[\tau_r r a(s) + \tau_c c(s) + \left(y(s) - \tau_0 y(s)^{(1-\tau_1)}\right)\right] d\Phi + Q$$

6. *Social Security's budget balances:*

$$\tau_{SS} w L = b(x) \int_S d\Phi \left(s_{-j}, \{J_R, \ldots, J\}\right)$$

7. *Accidental bequests equals the savings left from deceased households:*

$$Q = \int_S (1 - \psi_{j+1}) a' (s) \, d\Phi (s)$$

8. *Given the decision rules, Φ satisfies:*

$$\Phi(\omega) = \int_S M(s, \omega) d\Phi, \ \forall \omega \subset \mathcal{B}(S)$$

where $M : (S, \mathcal{B}(S)) \to (S, \mathcal{B}(S))$, can be written as folllows: $\forall j \in \{2, \ldots, J\}$,

$$M(s, \omega) = \begin{cases} \pi_{z,z'} \cdot \psi_{j+1} \ , \quad \textit{if} \ \ a'(s) \in \mathcal{A}, \ h'(s) \in \mathcal{H}, \ k \in \mathcal{K}, \ \theta \in \Theta, \ j+1 \in \{2, \ldots, J\} \\ 0 \ , \ \textit{otherwise.} \end{cases}$$

and for $j \in \{1\}$,

$$\Phi \left(S_{-J}, 1 \right) = (1 + g_n) \begin{cases} \displaystyle\sum_{k \in \mathcal{K}, \theta \in \Theta} p_k \cdot p_\theta \ , \quad \textit{if} \ \ 0 \in \mathcal{A}, \ h_0 \in \mathcal{H}, \ \bar{z} \in \mathcal{Z} \\ 0 \ , \ \textit{otherwise,} \end{cases}$$

where p_k and p_θ are, respectively, the probabilities of being a household with children and of drawing θ out of its discretized distribution. The initial conditions are $a_0 = 0$, $h_0 = 1$, and $\bar{z}$, the average level of productivity.

1.A.5 Welfare Calculation

In this section I describe in detail how to derive the consumption equivalent variation that quantifies the welfare costs of the UBI reforms. I follow steps analogous to the ones in Krueger, Mitman, and Perri (2016b).

The procedure consists basically of computing lifetime utility and how it changes if, at any point in time t and for every state of the world it is scaled by a factor of $1+g$. Denote the lifetime utility of a age $j=1$ household with individual state-space s_{-j} by $v(s_{-j}, j=1)$ and the lifetime utility of the scaled-up consumption sequence by s_{-j} by $v(s_{-j}, j=1; g)$ [19].

First, we find the lifetime utility using the functional form for the utility function described in the calibration:

$$
\begin{aligned}
v(s_{-j}, j=1) &= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) u(c_j, l_j)\right] && (1.23)\\
&= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \left\{\log(c_j) - \varphi \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] && (1.24)
\end{aligned}
$$

Now applying the scalling factor we have that:

[19] Here I borrow the typical notation in game theory that, given a vector v with arbitrary entries $i \in I$, we denote the same vector but excluding specific entry i_0 by v_{-i_0}.

$$\begin{aligned}
v(s_{-j}, j=1; g) &= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \left\{\log[(1+g)c_j] - \varphi \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] \\
&= \mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \left\{\log(1+g) + \log(c_j) - \varphi \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right] \\
&= \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \log(1+g) \qquad (1.25) \\
&+ \underbrace{\mathbb{E}\left[\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \left\{\log(c_j) - \varphi \frac{l_j^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}\right\}\right]}_{=v(s_{-j}, j=1)} \\
&= \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i\right) \log(1+g) + v(s_{-j}, j=1) \qquad (1.26)
\end{aligned}$$

If we ask the question by what percentage g do we need to increase consumption in the initial stationary equilibrium for the households to be indifferent between living in the old equilibrium and the new one, we are simply finding the g that solves the following equality:

$$v^{MT}(s_{-j}, j=1; g) = v^{UBI}(s_{-j}, j=1) \qquad (1.27)$$

where v^{MT} denotes that the equilibrium value function is relative to the initial means-tested steady-state and v^{UBI} denotes the one associated with the new steady-state under one of the UBI counterfactuals. Using equations (1.26) and (1.27), we can characterize the factor g:

$$v^{UBI}(s_{-j}, j=1) = \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right) \log(1+g) + v^{MT}(s_{-j}, j=1) \tag{1.28}$$

$$\implies g(s_{-j}, j=1) = \exp \left\{ \frac{v^{UBI}(s_{-j}, j=1) - v^{MT}(s_{-j}, j=1)}{\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right)} \right\} - 1 \tag{1.29}$$

which is defined for a newborn household with characteristics s_{-j}. If we want to evaluate the consequences of the reform *under the veil of ignorance*, i.e., before any identity is revealed, we can integrate over the state-space and redefine g as:

$$g^{SS} = \exp \left\{ \frac{\int_S v^{UBI}(s_{-j}, j=1) d\Phi(s) - \int_S v^{MT}(s_{-j}, j=1) d\Phi(s)}{\sum_{j=1}^{J} \beta^{j-1} \left(\prod_{i=1}^{j} \psi_i \right)} \right\} - 1 \tag{1.30}$$

Finally, in order to make the same evaluation but taking into account the transition, we perform the same thought experiment but considering the comparison between a previous steady-state and the enacted period of the reform. Denoting v^{MT}_{∞} the value function associated with the starionary equilibrium under means-testing and $v^{UBI}_{t=1}$ the value function under the new UBI regime but at the period that the reform is enacted, we can define associated g:

$$g^{Trans} = \exp\left\{\frac{\int_S v_{t=1}^{UBI}(s_{-j}, j=1) d\Phi_{t=1}(s) - \int_S v_{\infty}^{MT}(s_{-j}, j=1) d\Phi_{\infty}(s)}{\sum_{j=1}^{J} \beta^{j-1}\left(\prod_{i=1}^{j} \psi_i\right)}\right\} - 1 \tag{1.31}$$

1.A.6 Computation of the Model

Recursive Competitive Equilibrium

I solve for the households' problem by backward induction. The algorithm is similar to the one in Fabian Kindermann and Krueger (2018). Households surviving to the last period J have an immediate solution as $v_t^R(s_{-j}, J+1) = 0$. Aggregate quantities and prices are found by taking the following steps:

1. Guess initial values for K_t, L_t, $\tau_{c,t}$, and $\tau_{SS,t}$;

2. Given such initial values, use the firm's first-order conditions to obtain r_t and w_t;

3. Given prices and policy parameters, set value function after the last age to 0 and solve the value function for the last period of life for each point of the grid. This yields policy functions and value functions over retirement $v_t^R(s)$;

4. Also given prices and policy parameters, solve for the household's decision rules by backward induction and value function iteration repeating it until the first period of life;

5. Use forward induction to compute the associated distribution of households using the policy functions starting from the known distribution at the beginning of the life cycle;

6. Use the equilibrium conditions to update the values of the guessed variables and to compute all other aggregate variables;

7. Use dampening to obtain the new values for K_t and L_t, check the whether the associated markets clear;

8. Iterate until convergence.

Details of the computation

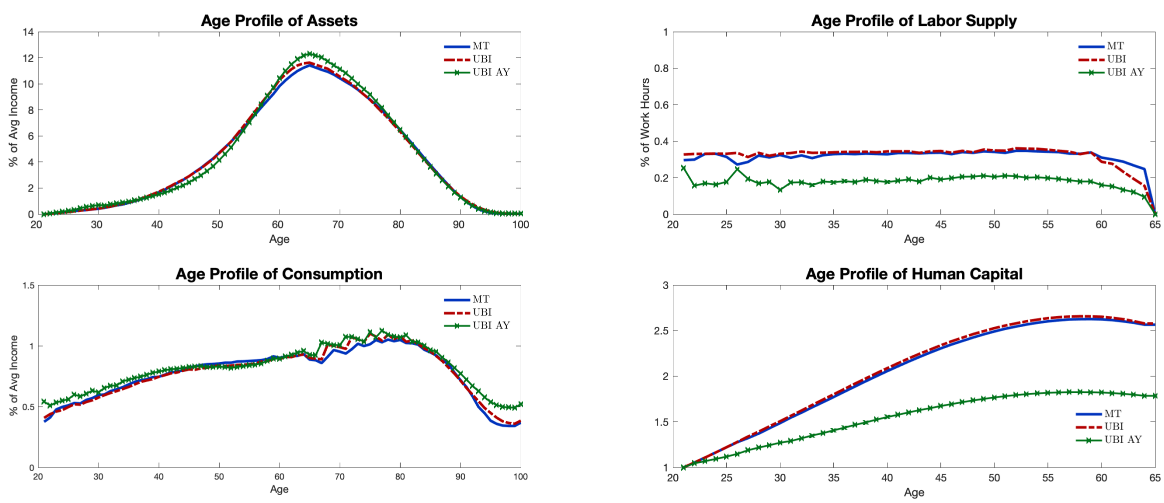
I discretize all continuous dimensions of the state-space: assets, human capital, productivity shocks, and permanent ability levels. I do so in 300, 50, 5 and 2 points, respectively. The children component is a binary index $k \in \{0, 1\}$, and the age list $j \in \{1, \ldots J\}$ has 80 points. The transition is assumed to converge in 45 periods, adding the associated number of points. I also discretize the labor choice in 50 points and use brute force grid search in the intra period decision of the household's labor supply. I include an extra loop for precision on evaluation of the extensive margin. The value function iteration to find the choice of next period's optimal assets is also done by brute force grid search. I use a grid with more nodes at the lower end. I also explore monotonicity and the envelope condition to increase efficiency. The household problem is solved taking advantage of single-node parallelization with OpenMP. As there are values for the human capital allocation that lie outside of the state-space defined by the grids, I use linear interpolation in order to find indices for the next period's value function and the stationary distribution. Following Fabian Kindermann and Krueger (2018), I discipline the choice of the assets' grid $\{\hat{a}^1, \ldots, \hat{a}^i, \ldots \hat{a}^{300}\}$ by using the formula:

$$\hat{a} = \bar{a}\frac{(1+g_a)^{i-1} - 1}{(1+g_a)^{299} - 1} \tag{1.32}$$

where $\bar{a}$ is the upper bound of the discrete space which is chosen such that no household saves more than this amount and $g_a > 0$ is the growth of the distance between points. I have profited and adapted from several sources in the writing of the code for this project, some of those were Guner, Lopez-Daneri, and Ventura (2016) and Fehr and F. Kindermann (2018).

1.A.7 Life-Cycle Profiles

Figure 1.5: Average life-cycle profiles in the three steady-states analyzed.



Chapter 2

Optimal Unemployment Insurance Requirements

by Gustavo de Souza[†] and André Victor Doherty Luduvice[‡]

2.1 Introduction

Unemployment Insurance (UI) programs have attracted the attention of the economic literature both because of its moral hazard component and its widespread presence in many modern economies (Dhushyanth and Vodopivec, 2002). The design of such programs are usually characterized by three main elements: a replacement ratio, which is the percentage from a past wage which the worker receives during the unemployment spell, a limit of how many months the worker can collect such benefits, and some type of requirement related to the worker's labor market history that deems them eligible to enrollment in the program. In this paper we study empirically and quantitatively

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how UI requirements in the U.S. affect the labor market and compute what is their optimal level.

The replacement ratio is the typical policy instrument employed to overcome the moral hazard disencentive channe of UI while keeping the insurance value of the benefits. By reducing or making the ratio decreasing during the unemployment tenure, workers can be encouraged to either keep their current jobs, had they been thinking of quitting, or stay less periods in the unemployed state, thus incentivizing the acceptance of new offers (Hopenhayn and Nicolini, 1997). We depart from this classical result of the literature by shifting the focus to the eligibility requirements.

In U.S. states in particular, unemployed workers must satisfy one or two specific requirements: a tenure requirement, i.e., a minimum amount of periods formally enrolled on a job in order to be eligible for the UI, and a monetary requirement, which establishes a minimum weekly wage earned by the worker in its previous job in order to be enrolled in the program. One of the main issues often raised in the UI literature that motivates the use of these instruments is the lack of information by the policy maker. The government has a limited capacity to observe the amount of effort that the unemployed agent exerts to find a new job, how much effort she makes to keep her current job, or even how many offers of other jobs are arriving to that worker. Even though there is this potential inefficiency, the literature has often found programs such as the UI to be welfare-improving. The intuition is simple, in the case of incomplete markets, as the UI works as a state-contingent instrument that helps households smooth consumption in a state of the world where they need the most, unemployment. Our analysis then asks the question of which of the instruments associated with the UI can maximize welfare in an incomplete markets environment.

We first conduct an empirical analysis to assess the UI requirements effects on employment outcomes and obtain stylized facts that we rationalize with our quantitative exercises. Following an approach similar to Hagedorn, Manovski, and Mitman (2016b), we use discontinuities in the UI policies to identify the causal effect of the UI requirements on the labor market. We use fixed effects at the *Metropolitan Statistical Areas* (MSAs) level and find that the monetary requirement has a stronger effect on disincentivizing UI benefit applications. The intuition for this result comes from the fact that a tenure requirement does not influence workers to stay at the same job as any position helps qualifying for the program, whereas the monetary requirement incentivizes workers to keep high-paying jobs. This result is corroborated by a similar effect with opposite signs for the coeffcients of the requirements, with the positive effect stemming from the tenure eligibility constraint. We also find the same pattern when the outcome variable is the number of employers that workers had in the year previous to their application for the UI benefits.

In our quantitative analysis, we develop an infinite horizon partial equilibrium model with incomplete markets and heterogeneous agents. Workers have their individual state-space defined by their holding of assets, their labor income and supply histories, and their idiosyncratic productivity component. They make choices on consumption, savings and their discrete labor supply. The model has embedded a UI program that closely mimics the design in the US with its policy instruments and requirements. As we assess the behavior of workers both in and out of the labor force, agents receive employment and unemployment shocks, adding the associated possibility of a involuntary unemployment state. On top of that, in order to account for heterogeneity in benefits and the moral hazard component intrinsically attached to the UI benefit, we include ad-hoc moral hazard and loss of benefit shocks. With this shock structure, we are able to characterize a set of unemployed workers with defrauding behavior towards the UI requirements. In the model economy, the government administers the UI system and balance its budget with taxes, exogenous expenditures, and a universal unemployment transfer. Following Hopenhayn and Nicolini (2009) and the repeated moral hazard literature, we add an informational friction in which the government cannot perfectly distinguish quits from lay-offs.

In order to compute the model efficiently, we introduce a methodology to reduce the infinite-dimensional state-space defined by the sequences of labor income and supply histories. By focusing on the relevant part of such histories along with its average values, we are able to rewrite the workers problem in a tractable manner while still keeping it fully history-dependent and rich enough state to accomodate the requirements details of the UI program. We bring the model to the data by calibrating exogenous and endogenous parameters. We are able to successfully replicate the targeted moments with our seven endogenous parameters as well as select non-targeted moments that are relevant to deem the model valid for the analysis of our research question. Furthermore, we observe that in our benchmark economy, the overall behavioral response to adjustments in the UI policy parameters is consistent with the evidence we collect in our empirical analysis. In particular, we are able to recover the negative relation between the monetary requirement and the employment outcomes and the associated positive impact of the tenure requirement.

Such association is obtained when we compute a sequence of counterfactual experiments that analyze the effects on the economy of varying each of the UI policy parameters on a *coeteris paribus* basis. In the results of our exercises, we also observe that a stricter monetary requirement significantly reduces the share of workers entering the UI system that are not technically qualified to do so. The intuition for this effect comes from the fact that the monetary requirement is able to precisely preclude low productivity workers from having access to the UI benefits. Furthermore, a stricter requirement also incentivizes a higher share of workers to exhaust the period for which they are entitled to receive the benefits. The tenure requirement, on the other hand, has negligible numerical impact in labor market outcomes subject to moral hazard.

Finally, we conduct a normative analysis of the design of the UI program by evaluating the model's welfare response to different numerical values for the policy instruments. More specifically, we maximize a utilitarian Social Welfare Function (SWF) on a restricted Ramsey problem and assess the level of Consumption Equivalent Variation (CEV) associated with the optimal parametric region for the tuple that characterizes the program. We find that the highest level of welfare is achieved, when evaluated separately, by a monetary requirement that is relatively larger than the benchmark value. As only the low productivity households exhibits a significant reaction to changes in the UI policy in their behavior towards the labor market, the monetary requirement is more efficient in targeting workers in that region of the distribution. The second highest level of welfare is achieved by a reduction in the replacement ratio, though that augments the pool of beneficiaries which makes this instrument less efficient on our restricted sense when compared to the monetary requirement. Finally, optimizing the problem with a combination of both requirements, including the one on tenure, is able to achieve an even higher level of CEV by further reducing the total expenditure of the government with with a stricter tenure requirement at the optimum.

This paper is organized as follows. In the next section we discuss the related literature. Section 2.3, we show the empirical evidence obtained of the effect of UI requirements on employment outcomes. In Section 2.4, we construct the setting of our quantitative model, provide intuition about the underlying theory, and define all relevant model objects. In the subsequent Section 2.5, we describe the calibration used to map the model to the data. Section 2.6 presents the results for the benchmark economy and the properties of the initial steady-state. Section 2.7 lays-out the thought experiment and the results of counterfactual analyses. In Section 2.8, we conduct a normative analysis and search for the optimal UI policy within the model environment. The last section states our conclusions.

2.2 Related Literature

This paper builds on the literature that assesses numerically the effects of unemployment insurance policies in the labor market. One of the earliest and most influential references is Hansen and Imrohoroğlu (1992), who constructs a quantitative incomplete markets model with moral hazard to anaylze the optimal replacement ratio. On a similar environment but with a focus on the search-theoretic component, Gomes, Greenwood, and Rebelo (2001) study the welfare cost of business cycles. Pallage and Zimmermann (2001) extends the same model setting for heterogeneity of skills and studies the voting preferences towards UI generosity. Abdulkadiroglu, Kuruscu, and Sahin (2002) moves one step further in the canonical framework by making the unemployment insurance dependent on how much time the agent has been in an unemployment state. They find out that the optimal UI has to decrease on time during the unemployment spell and that it should be larger if agents are prevented from saving. We use this formulation as a reference starting point for the modelling strategy used in this paper.

Still in the quantitative approach with heterogeneous agents, Young (2004) incorporates search effort in the numerical analysis in order investigate the heterogeneity of optimal replacement ratios suggested by the literature. The author finds that the optimal ratio should be zero independent of limits of benefit duration and that eliminating the UI system generates welfare gains which get smaller if one takes the transition into account. Lentz (2009) further confirms the importance of including transitional dynamics when effort choice is present by estimating a search model of optimal UI policy with Danish data. Zhang and Faig (2012) study the eligibility to UI in a Diamond-Mortensen-Pissarides environment and find a Ricardian Equivalence type of result in which taxation of risk neutral households anulates the job creation effect of the employment requirement. A reference with a similar approach of quantitatively identifying the UI design in a heterogeneous agents economy but with an endogenization of the labor market in a search and matching framework is the one in Mukoyama (2013). On a more recent contribution but in an environment with search, Mazur (2016) identifies large welfare gains from a policy that allows quitters to receive UI benefits.

We contribute to this branch of the literature by developing quantitative model of optimal unemployment insurance incorporating a fully history-dependent UI program. We model that, to become eligible to the UI benefits, the agent must satisfy the UI requirements, which test the households' labor market history that needs to be present in the workers' states-space. Moreover, we focus on the optimality of such requirements, a question that is, to the extent of our knowledge, still open in the literature.

The empirical strategy used in our econometric evidence can be tied with what is now a rich literature that analyzes changes in UI features in the context of recessions. More specifically, the literature studies the extension of UI benefits that was granted for up to 73 weeks during the Great Recession. We discuss the institutional background details in the section 2.3.1. Marinescu (2017), for example, studies the general equilibrium effects of the extension on job applicants and vacancies. The methodology of using discontinuity in state borders is also present in a sequence of papers that use it to asses the labor market and equilibrium effects of the recession episode (Hagedorn, Manovski, and Mitman, 2016b; Hagedorn, Manovski, and Mitman, 2016a; Hagedorn, Karahan, et al., 2019). Recent quantitative and theoretical approaches studying the relation between UI and recessions are Mitman and Rabinovich (2015) and Pei and Xie (2020).

Our paper also dialogues with a long tradition of theoretical papers of optimal unemployment insurance design. The earliest contribution can be found in the seminal work by Shavell and Weiss (1979). Authors find that if workers have no influence in their job finding probability the optimal payment schedule during the unemployment spell stays constant at a positive level. On the other hand, in an environment where the worker can exert effort to find a job, a moral hazard problem arises and the sequence optimal payments might fall during the period that the worker is unemployed. The early work by Wang and Williamson (1996) find that an optimal system with moral hazard would involve a tax and subsidy scheme penalizing the transition from employment to unemployment and incentivizing the converse. Another canonic article is the one by Hopenhayn and Nicolini (1997). The environment is a repeated principal-agent problem where the principal cannot observe the agent's effort. The authors are able to characterize the optimal contract and lay-out a result which is currently well-known in the literature: the optimal payment schedule involves a replacement ratio which is decreasing during the unemployment spell and a reemployment wage tax that increasing with the length of such spell. Other seminal references on the search incentives generated by the UI are Chetty (2008) and Shimer and Werning (2008).

In close relation with our approach is the extension of the original article in Hopenhayn and Nicolini (2009). They amplify the environment to account for multiple unemployment spells with asymmetric information in order to study the optimality of the eligibility condition common in UI programs. The main result of the paper is that, if the principal cannot distinguish quits from lay-offs, it is optimal for the principal to condition benefits payments on the agent's past employment history. A similar idea is present, though not as an endogenous outcome, but with an ad-hoc formulation of the environment win the experience rating component used by Wang and Williamson (2002). As in our environment we search for a quantitative design of an UI program that is characterized by an eligibility condition, we will profit from the result in Hopenhayn and Nicolini (2009) and assume that the government in our model has the same informational limitation suggested assumed in their paper.

2.3 Empirical Evidence

In this section we study empirically how the UI requirements affect the labor market in the U.S. In subsection 2.3.1 we briefly describe the institutional background of the unemployment insurance in the different states. We describe our data in 2.3.2 and the empirical strategy used in 2.3.3. We then outline the results of the econometric exercises in 2.3.4.

2.3.1 Institutional Background

The unemployment insurance in the U.S. is regulated by the federal government, administered by the States and paid weekly to workers who have been displaced of their jobs by no fault of their own. The eligibility requirements beyond the determination of reason for displacement are established by each individual State law in reference to a *base period* which is usually the first four out of the last five completed calendar quarters prior to the time the claim is filed. The majority of the states fund the program through a tax imposed on employers [1].

[1] The U.S. Department of Labor provides further details on the legislation and broader components of the UI regulation, the website can be found via this link.

One of the last substantial revisions to the UI federal law has been in 2009 with the *American Recovery and Reinvestment Act*, which largely extended the duration of benefits due to the Great Recession with the *Emergency Unemployment Compensation* (EUC) and *Extended Benefits* (EB) measures. The baseline period for most of the states was of 26 weeks, which were topped up with additional 13 to 20 weeks by the Act. The most recent significant revision was in 2012 and extended the programs from the previous revision and added legislation on self-employment eligibility and short-term compensation possibility for employers. The EUC and EB were last extended until 2014. As mentioned previously, these revisions have focused solely on the duration of payment of benefits and have received due attention from the literature[2].

2.3.2 Data

We conduct our econometric analysis using data from the IPUMS repository of the *Annual Social and Economic Supplement* (ASEC) of the *Current Population Survey* (CPS) between 1963 and 2016. We combine the labor market statistics from this sample with data on state unemployment insurance laws taken from the *U.S. Department of Labor* (USDL). The region of focus are the MSAs. A more detailed description of the data can be found in Appendix 2.A.1. For the current analysis, we do not perform any sample selection but rely on demographic controls in our regressions.

2.3.3 Empirical Strategy

We use state policy changes on UI requirements to identify their causal effect. The peril of such approach is the possibility of state level shocks that correlate with such policy changes. Those could be a threat to the correct identification of the effect. For

[2] See our review in Section 2.2.

instance, if policymakers refrain from increasing UI requirements during recessions or if they change tenure requirement accordingly to the state average job duration, a traditional diff-in-diff strategy would be biased.

UI reforms are also potentially correlated with state specific trends: policy makers are less likely to increase requirements in a crisis period (Hagedorn, Manovski, and Mitman, 2016a). The intuition is that increases in employment duration make UI tenure requirement less binding and hence political support for stricter requirements might also increase. In order to deal with such potential issues, we use the discontinuity of UI requirements at state borders. The idea behind is that MSAs at different sides of a state border are subject to the same shock but to different UI policies.

The specification of our econometric model is:

$$y_{i,m,s,b,t} = \beta_M \text{monreq}_{s,t} + \beta_T \text{tenurereq}_{s,t} + X'_{i,m,s,b,t}\theta + \mu_m + \gamma_{b,t} + \epsilon_{i,m,s,b,t} \tag{2.1}$$

where $y_{i,m,s,b,t}$ is a labor market outcome of agent i, at MSA m and state s, which is a member of the border pair identified by b at time t. The monetary requirement in state s at time t is $\text{monreq}_{s,t}$ while $\text{tenurereq}_{s,t}$ is the tenure requirement. Finally, $X'_{i,m,s,b,t}$ is a set of controls, μ_m is a MSA fixed effect while $\gamma_{b,t}$ is a border-year fixed effect. The set of controls used in our regression results are workers' demographics, more specifically, age, years of education, sex, race and marital status.

If shocks that lead to UI requirement changes are continuous over state borders, it should affect the two sides of a border pair b, hence being captured by the fixed effect $\gamma_{b,t}$. This guarantees the identification of the two coefficients of interest, β_M and β_T, which capture, respectively, the effects of the monetary and the tenure requirements.

2.3.4 Results

We summarize our results using MSAs as our baseline region in Table 2.1. The estimates obtained indicate that UI requirements affect the labor market outcomes at a significant level. The requirements impact the kind of jobs individuals take, specially those that are part-time but also the UI applications and their number of jobs. Overall, the monetary requirement impacts the labor market employment outcomes negatively and in an opposite direction to the tenure requirement.

Table 2.1: Results of econometric analysis at the MSA level.

	(1)	**(2)**	**(3)**	**(4)**
	UI Last Year	# Employers Last Year	Part Time	Duration Last Job
D_{monreq}	-0.0256***	-0.0121***	-0.133***	-0.991
	(0.000)	(0.001)	(0.000)	(0.240)
$D_{\text{tenurereq}}$	-0.000567	0.0857***	0.0270***	-0.449
	(0.808)	(0.000)	(0.000)	(0.569)
Region	MSA	MSA	MSA	MSA
Border-Year FE	X	X	X	X
Region FE	X	X	X	X
N	222656	135764	149407	1449
R^2	0.899	0.051	0.017	0.300

p-values in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Note: The variable D stands for a dummy indicating the presence of the requirement. Outcome variables for regressions (1), (3), (4) are dummies indicating the ocurrence of the variable in the previous year. Outcome variable for regression (2) is numerical and continuous. The results are shown for the coefficient of interest of a regression with control variables for demographic characteristics.

As can be seen in the Table 2.1 above, we find in the first regression that the monetary requirement has a quantitatively stronger effect on disincentivizing UI benefit applications than the tenure requirement. This result comes from the fact that a tenure requirement does not necessarily influence workers to stay at the same job as any position can contribute to the spell that qualifies the worker for the UI program. The monetary requirement, on the other hand, incentivizes workers to stay in their jobs or focus on high-paying positions. This result is corroborated by a similar effect shown in the regression on the number of employers where there are opposite signs for the coeffcients of the requirements and the tenure requirement exhibiting a positve sign.

We also find the same pattern when the outcome variable is the whether or not workers are on part-time employment. Once again, policy changes on the monetary requirement affect negatively the outcome and in this case with a large effect. As the monetary requirement directly establishes a minimum wage, it is soemewhat by construction designed to preclude workers from temporary jobs to use these short spells to qualify for the benefit. The tenure requirement, though also focused on diminishing the disencentive of seach generated by the UI, has a positive effect on the part-time employment as it does not directly helps in selecting the type of position the unemployed workers enroll. Our last regression with the duration outcome has not shown significant coefficients. We conduct a robustness check with regressions at the county level[3].

[3]The results can be found in Appendix 2.A.2.

2.4 The Model

This section describes the dynamic partial equilibrium model we use to analyze the optimal degree of unemployment insurance requirements in the U.S. economy. The environment is an infinite horizon economy with incomplete markets and individual heterogeneity, discrete labor supply, labor income and supply histories, and an UI system that mimics the one of the U.S.

Households are heterogeneous with respect to their labor income history, $\tilde{\mathbf{y}} = \{\epsilon w\}_{j=0}^{\infty} \in \mathcal{Y}^{\infty}$, labor supply history, $\tilde{\mathbf{n}} = \{n_j\}_{j=0}^{\infty} \in \mathcal{N}^{\infty}$, their idiosyncratic productivity shock, $z \in \mathcal{Z}$, and their asset holdings $a \in \mathcal{A}$. The state space of the economy is then the set $S = \mathcal{A} \times \mathcal{Z} \times \mathcal{N}^{\infty} \times \mathcal{Y}^{\infty}$. In the subsections below, we discuss in detail every entry of the individual state space element $s = (a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}}) \in S$.

As the environment is set with the the underlying purpose of assesing the optimality of the UI system that will be analyzed only between steady-states, throughout the description of the model, we will selectively omit indices in order to avoid loading the notation. More specifically, we will denote all individual variables as defined over the individual state-space s, hence should also be understood as implicitly indexed by time t. As the aggregate variables are more naturally understood to be time-dependent, we will explicitly index them by t. Furthermore, as there is no distincition between the notion of a household and a worker in the theoretical setting of the model, we will interchangeably denote the agents of the model economy with either of these terms.

2.4.1 Preferences

The economy is populated by a continuum of households with a time-separable period utility function. Households maximize their discounted expected lifetime utility from nondurable goods consumption c and labor supply $n \in \{0,1\}$. It is defined as follows

$$\mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c,n)\right], \tag{2.2}$$

where β is the discount factor and $\mathbb{E}$ is the expectation operator. Households can also choose to accumulate assets $a \geq \underline{\mathrm{b}}$ to protect themselves against the idiosyncratic shocks, where $\underline{\mathrm{b}}$ is their borrowing limit.

2.4.2 Technology

There is a single good produced in this economy with technology given by a Cobb-Douglas production function that exhibits constant returns to scale, $Y = F(K_t, N_t) = K_t^{\alpha} N_t^{1-\alpha}$, where $\alpha \in (0,1)$ is the output share of capital income and Y_t, K_t and N_t denote, respectively, aggregate output, physical capital and labor. The final good can be consumed or invested in physical capital on a one-to-one basis.

The price of the consumption good is normalized to one and aggregate investment in physical capital, I_t, is defined by the following law of motion:

$$K_{t+1} = (1-\delta_k)K_t + I_t, \tag{2.3}$$

where δ_k is the depreciation rate of physical capital.

This technology is used by a representative firm that behaves competitively maximizing profits at every period t by choosing labor and capital given factor prices. The profit maximization problem is:

$$\Pi_t = \max_{K_t, N_t} K_t^{\alpha} N_t^{1-\alpha} - w_t N_t - (r_t + \delta_k) K_t. \tag{2.4}$$

which yields the following first-order conditions:

$$r_t = \alpha \left(\frac{K_t}{N_t} \right)^{\alpha - 1} - \delta_k \tag{2.5}$$

$$w_t = (1 - \alpha) \left(\frac{K_t}{N_t} \right)^{\alpha} \tag{2.6}$$

As the model economy is gonna be analyzed in partial equilibrium setting, the interest r_t will be given in the steady-state, with value r^*. From that value we recover K_t/N_t via equation (2.5) and thus, use equation (2.6) to determine the steady-state wage level w^*.

2.4.3 Endowments and Labor Income

Agents are born with zero assets and endowed with one unit of time. There can be two possible states for a household, employed or unemployed. In either case, the household receives two types of shocks: an unemployment or employment shock and a productivity shock, z. There is no aggregate uncertainty. The component z is persistent and follows an AR(1) process defined by:

$$z_{t+1} = \rho z_t + \varepsilon_t, \; \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \tag{2.7}$$

which is discretized in a Markov chain with transition matrix $\pi_{z,z'} = \Pr(z_{j+1} = z' | z_j = z)$ and stationary distribution $\Pi(z)$.

An employed worker with productivity z in the previous period receives at the beginning of the current period an unemployment shock with probability p_u and a a productivity shock $z' \in \{z_1, ..., z_N\}$ with probability $\bar{\Pi}(z'|z)$. While working, individual earnings depend on the competitive wage w_t and the idiosyncratic persistent component. Workers pre-tax labor income is then defined by:

$$y(n, z) = w \cdot z \cdot n \tag{2.8}$$

On the other hand, an unemployed household in the previous period receives at the beginning of the current period an employment shock with probability p_e and a productivity shock $z \in \{z_1, ..., z_N\}$ with probability $\tilde{\Pi}(z')$.

We interpret each different shock $z > 0$ as a given productivity in the same job and assume that if $z = 0$ the agent is laid-off. Hence, in accordance to the current U.S. unemployment insurance code, agents with $z > 0$ should not receive the unemployment benefit, while only agents with $z = 0$ and attending the required eligibility criteria are able to collect it. We relax this hypothesis later on in order to capture the moral hazard component. Without loss of generality, we can collapse all shocks in one vector and rewrite the effective labor income process as $\Pi(z'|z)$, where $z' \in \{0, z_1, ..., z_N\}$.

2.4.4 Unemployment Insurance and Moral Hazard

The unemployment insurance program is designed to approximate the regulation in the US. Let $b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})$ be the UI benefit of an agent with labor market history $(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})$.

The government pays UI benefits benefits b^{UI}, which amount to a percentage of the average past earnings characterized by a replacement ratio $\theta \in [0, 1]$. It does so for a limited amount of periods $\{0, \ldots, \mu_b\}$, with $\mu_b \in \mathbb{N}$. It requires a minimum amount of consecutive periods working for eligibility to the program, $\mu_t \in \mathbb{N}$, as well as a minimum threshold $z_{min} \in \mathbb{R}^+$ on the workers' average earnings. Thus, the

UI design is defined by the tuple $\{\theta, z_{min}, \mu_t, \mu_b\}$. We make the assumption that, in the model economy, every worker satisfying all requirements of the UI program will automatically receive the program benefits. That is equivalent to a take-up rate of 100%.

In order to capture the moral hazard component intrinsically embedded in the design of the UI, the workers will be subject to two ad-hoc shocks. First, there is a strict *moral hazard shock*: with probability φ, workers quitting the labor force, i.e. with $n = 0$ and $z > 0$, receive UI benefits. Second, in order to the model to be consistent with heterogeneity in benefit duration, there is an exogenous *loss of benefit shock*: with probability φ_{exo} the unemployed agent loses its UI benefit.

Finally, following Hopenhayn and Nicolini (2009) we impose an extra informational limitation to the government, which is implicit in the moral hazard structure of the model environment. We assume that the government and workers are in a principal-agent relation in which the former cannot perfectly distinguish quits from a layoffs. This is the exact condition that guarantees the eligibility requirement to arise as part of the optimal mechanism in the repeated moral hazard environment that is analyzed by the authors. Moreover, as the government does not observe whether a worker is defrauding the UI system due to the *moral hazard shock*, it also cannot perfectly distinguish her from an unemployed worker.

2.4.5 Government

The governments runs the UI system and its budget. The total revenue and expenditure of the UI system are defined, respectively, by $Rev_{UI,t}$ and $Exp_{UI,t}$. On top of that, the government issues a Social Security transfer $T_{u,t}$ paid to all unemployed households. There is an endogenous level of aggregate expenditure G_t, which is defined residually by what is left to balance the total government's budget. Finally, It taxes labor income with exogenously calibrated flat rate τ using the collected revenue to fund all expenses.

The universal transfer T_u in this context is important for two reasons: First, it accounts for the fact that the government has other financial duties beyond its expenditures on the unemployment insurance. Second, as the government provides insurance through other welfare and social programs, it is auxiliary in interpreting the numerical results derived through the paper as accounting for the redistribution desire and risk protection provided by the UI that exists on top of the these programs. This transfer works then as a reduced-form version of the transfer that households in the US have access via the *Income Security System*.

At any point in time t, the government's budget is balanced if, and only if:

$$G_t + T_{u,t} + Exp_{UI,t} = \tau(rK_t + wN_t) + Rev_{UI,t} \tag{2.9}$$

2.4.6 Timing

In each period t the following sequence of events happens: workers enter the period having received their labor market transition and productivity shocks. The final good market opens, and the government pays UI benefits. Then workers receive the moral hazard shock and the UI benefit loss shock. Given all these shocks, all agents make their consumption and savings choices. Subsequently, if employed and without a separation shock, they make their choice on whether to remain working or quit. If unemployed, they make the choice whether to remain unemployed or to initiate at work. If employed and having received an unemployment shock they collect benefits while deciding their allocations. If unemployed and having received no job offer, they behave analogously. At the end of the period, the government collects its revenues and balance its budget.

2.4.7 Recursive Household Problem

Let v_n be the value function of an agent conditional on its labor supply decision $n \in \{0, 1\}$. As defined previously, the individual state-space is $s = (a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}})$. The problem of this agent is thus represented in the recursive form in the Bellman equation (2.10) below:

$$
\begin{aligned}
& v_n(a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}}) = \max_{c,a'} u(c, n) + \beta \mathbb{E}_z \left[v_n(a', z', \{\tilde{\mathbf{n}}, n\}, \{\tilde{\mathbf{y}}, wzn\}) \right] \\
& \text{s.t.} \\
& c + a' = (1 + (1 - \tau)r)a + (1 - \tau)wzn + (1 - n)T_u + (1 - n)b^{UI} (\tilde{\mathbf{n}}, \tilde{\mathbf{y}}) \\
& \qquad c > 0, \qquad a' \geq \underline{\mathrm{b}}, \qquad n \in \{0, 1\}
\end{aligned}
\tag{2.10}
$$

The solution of the problem above defines consumption and asset allocations conditional on state s. Given these allocations, we can determine the final value function and the labor supply decision by the following maximization:

$$
v(a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}}) = \max\{v_1(a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}}), v_0(a, z, \tilde{\mathbf{n}}, \tilde{\mathbf{y}})\} \tag{2.11}
$$

The solution of the dynamic programs (2.10) and (2.11) provides us the decision rules for the asset holdings $a : S \to \mathbb{R}_+$, consumption $c : S \to \mathbb{R}_{++}$, and labour supply $n : S \to \{0, 1\}$.

2.4.8 Reduction of the State-Space

In the previous sections we have described the elements of the workers' state-space s. We have kept the notation initially introduced for exposition purposes and to make it simpler to write down the recursive household problem. Nonetheless, the state-space contains the agents' full labor supply and income history $(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})$ which are infinite dimensional objects in the steady-state of the model. Hence, in the way we have the problem defined so far it is, by construction, untractable for a numerical solution. In this subsection we explain how we make a reduction of the state-space to make the problem feasible. The principle behind the arithmetic we describe lies on only keeping track of the agents' relevant labor supply history and average earnings.

First we need to reduce the size of the agents' labor supply history $\tilde{\mathbf{n}}$. Given that the UI program needs to keep track of how many periods the agent has been working, the effective time span needed in the state-space at any period t is completely determined and sized by the minimum tenure requirement μ_t. Hence, the agent satisfies this requirement if $n_\ell = 1$ for all $\ell \in \{t - \mu_t - 1, ..., t - 1\}$. Denote $\bar{n} = \{n_\ell\}_{\ell=t-\mu_t}^{t-1}$ the agent's *relevant labor supply history.*

In our description before, the algebraic formula of the benefit was omitted due to the many layers and implicit calculations. In order to make one of these layers explicit, we introduce an extra, albeit numerically redundant, variable m, standing for the number of periods the worker has been receiving UI. The set $\{b^{UI} > 0\} \cap \{0 < m < \mu_b\}$ determines whether the agent satisfies all conditions to receive the benefit next period. We can then compute the next period's benefit eligibility in terms of periods received using the following law of motion:

$$m_{t+1} = (m_t + 1)\mathbb{1}_{\{b^{UI}>0\}\cap\{0<m<\mu_b\}} \tag{2.12}$$

where the notation $\mathbb{1}$ stands for the indicator function. With the variables introduced above, we then have reduced all relevant information from *labor supply history* $\tilde{\mathbf{n}}$ into $(\bar{n}, m)$

In order to tackle the reduction of dimensionality of the agents' labor income history $\tilde{\mathbf{y}}$, we construct the variable $\bar{y}$. It captures the *average labor income history* of an agent that has worked for t consecutive periods:

$$\bar{y} = \begin{cases} \sum_{i=1}^{t} \frac{y_i}{t}, \text{ if } t \leq \mu_t \\ \sum_{i=1}^{t-\mu_t} y_{\mu_t+i} \frac{\mu_t^{t-\mu_t} - i}{(\mu_t+1)^{t-\mu_t-i+1}} + \frac{\mu_t^{t-\mu_t}}{(\mu_t+1)^{t-\mu_t+1}} \sum_{i=1}^{\mu_t} \frac{y_i}{\mu_t} \end{cases} \tag{2.13}$$

Which can be updated recursively as

$$\bar{y}_{t+1} = (1-\tau) w z_t \frac{1}{t+1} + \bar{y}_t \frac{t}{t+1} \tag{2.14}$$

With this summary statistic, we can implement a reduction of the state space from the *labor income history* $\tilde{\mathbf{y}}$ to $\bar{y}$.

The set $\{n_\ell = 1, \forall n_\ell \in \bar{n}\} \cap \{0 < m < \mu_b\} \cap \{\bar{y} \geq z_{min}\}$ is thus able to fully determine whether the agent satisfies all requirements to receive the benefit at the period and we can then define an indicator function $\mathbb{1}$ over it. This allows us to write a proper algebraic characterization of the formula for the UI benefits $b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})$ as it is implemented in quantitative solution of the model:

$$b^{UI}(\bar{n}, m, \bar{y}) = \theta\,\bar{y}\,\mathbb{1}_{\{n_\ell=1,\forall n_\ell \in \bar{n}\}\cap\{0<m<\mu_b\}\cap\{\bar{y}\geq z_{min}\}} \tag{2.15}$$

It is important to notice that, following US tax regulations, the benefits are subject to income taxation. Hence, when we update the next period's income $\bar{y}_{t+1}$ according to the law of motion in (2.14), we are already including the post-tax income in the state-space.

2.4.9 Partial Equilibrium

Agents are heterogeneous at each point in time in the state $s \in S$. The agents' distribution among the states s is described by a measure of probability Φ defined on subsets of the state space S. Let $(S, \mathcal{B}(S), \Phi)$ be a space of probability, where $\mathcal{B}(S)$ is the Borel σ-algebra on S. For each $\omega \subset \mathcal{B}(S)$, $\Phi(\omega)$ denotes the fraction of agents that are in ω. There is a transition function $M(s, \omega)$ which governs the movement over the state space from time t to time $t+1$ and that depends on the invariant probability distribution $\Pi(z)$ and on the decision rules obtained from the household's problem. We define such distributional share as stationary when $\Phi_{t+1} = \Phi_t = \Phi$.

The definition below stands for a stationary equilibrium and I omit the arguments of the distribution for notational convenience. Furthermore, for expositional purposes, the definition is written using the notation assoaciated to the the full state-space as initially defined in the description of the model.

Definition 3 (Stationary Recursive Partial Equilibrium)**.** *Given an UI program $\{\theta, z_{min}, \mu_t, \mu_b\}$, a tax τ, and exogenous prices $\{r^*, w^*\}$, a partial equilibrium for this economy is an allocation of value function v, policy functions, residual expenditure G, and universal transfer T_u, such that:*

1. *Given prices* $\{r^*, w^*\}$*, the UI program, fiscal policy, and government transfer,* v *solves the the workers' problems in (2.10) and (2.11) and* $\{c, a', n\}$*, are the associated policy functions;*

2. *The individual and aggregate behaviors are consistent:*

$$K = \int_S a_t'(s)\, d\Phi(s)$$

$$C = \int_S c_t(s)\, d\Phi(s)$$

$$L = \int_S z \cdot n(s)\, d\Phi(s)$$

$$N = \int_S n(s)\, d\Phi(s)$$

3. *The government's budget constraint is satisfied:*

$$G + T_u + \int_S b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})\, d\Phi(s) =$$
$$\tau \left(r^* \int_S a_t'(s)\, d\Phi(s) + w^* \int_S z \cdot n(s)\, d\Phi(s) + \int_S b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})\, d\Phi(s) \right)$$

4. *Given the decision rules,* Φ *satisfies:*

$$\Phi(\omega) = \int_S M(s, \omega) d\Phi,\ \forall \omega \subset \mathcal{B}(S)$$

where $M : (S, \mathcal{B}(S)) \to (S, \mathcal{B}(S))$*, can be written as folllows:*

$$M(s, \omega) = \begin{cases} \pi_{z,z'}\,, & \text{if } a'(s) \in \mathcal{A},\ \tilde{\mathbf{n}}'(s) \in \mathcal{N}^\infty,\ \tilde{\mathbf{y}}'(s) \in \mathcal{Y}^\infty \\ 0\,, & \text{otherwise.} \end{cases}$$

2.5 Calibration

2.5.1 Timing, Preferences and Technology

We define the time period of the model to be equivalent to 6 weeks. The period utility is isoelastic in consumption c and separable with respect to the labor supply n:

$$u(c,n) = \frac{c^{1-\gamma}}{1-\gamma} - \chi n \tag{2.16}$$

where γ is the coefficient of relative risk aversion and χ controls the disutility of labor. We calibrate the latter to match the average labor force participation (LFP) of the US economy computed as the average between 1979 and 2014 taken from the *Bureau of Labor Statistics* data for men 20 years or older. We set $\gamma = 1$, hence assuming $\log(c)$ form throughout our numerical exercises. We endogenously calibrate β to match the average wealth to income ratio in the US, which is taken from our own calculations using the *Survey of Consumer Finances* of 2010 and 2013. (SCF).

Following Cooley and Prescott (1995) we set the capital share α to 0.36, a value already standard in the literature. We exogenously set the partial equilibrium interest rate r^* to the six-week value that is equivalent to 2% per year. For the depreciation rate of capital δ, we follow Gomes, Greenwood, and Rebelo (2001) and set it to the six-week value that is equivalent to 5% per year.

2.5.2 Endowments and Labor Income

We prevent all workers' from borrowing hence setting $\underline{b} = 0$. We follow Gomes, Greenwood, and Rebelo (2001) and calibrate the the persistence ρ and the error variance σ_ε^2 of the AR(1) process governing the labor income shock to 0.9 and 0.052, respectively. The probability of finding a job p_e is calibrated endogenously to simultaneously match the average duration of UI benefits and the measure exhausting the number of payments of the UI benefits. We also calibrate endogenously the probability of loosing a job p_u set to match average job destruction. Our target is based on our calculation of job losers as a share of the population from 1991 to 2014 using the data of the *U.S. Department of Labor* (USDL).

2.5.3 Unemployment Insurance and Government

The values for the parameters governing the UI system in the benchmark economy are calibrated exogenously. The replacement ratio θ is set to 0.4641, which is average of the U.S. average from 1989 to 2011 as provided by the USDL. The monetary requirement z_{min} is defined exogenously to be 0.5573, which is the 4th largest shock in the grid we use to discretize the AR(1) process in the computation. The maximum number of weeks that workers receive the benefit μ_b is 24, which is the closest number consistent with the average 26 weeks as reported by the U.S. Department of Labor. This is equivalent to 4 model periods, which otherwise amount to 30 weeks, had we considered 5 model periods. The same number of weeks is also required for households to attain the work tenure eligibility requirement μ_t.

The remaining parameters are all calibrated endogenously. The universal transfer T_u is calibrated to match the average transfer to unemployment over average labor income in the data. The target level for this statistic is calculated by us from the *American Community Survey* (IPUMS-ACS). The *moral hazard shock* φ is chosen to target the share of agents receiving UI in the US. The reference value for this moment is, once again, calculated from the average of the USDL data from 1991 to 2014. Lastly, the *loss of benefit shock*, φ_{exo}, together with p_e mentioned previously, targets the average duration of UI benefits and measure exhausting UI benefit.

2.5.4 Summary of Calibration

We summarize the information associated with the calibrated parameters in the sequence of tables below. In Table 2.2, one can find the exogenously calibrated parameters and their sources. Table 2.3 shows the endogenously calibrated parameters, the targeted moments associated with each of them, the source of such moments for their data counterparts and the value of such statistics computed for the model economy.

Table 2.2: Exogenously calibrated parameters.

	Parameter	**Value**	**Target / Source**
Timing			
Model's period	t	$\{1, \ldots \infty\}$	6 weeks (Hansen and Imrohoroğlu, 1992)
Preferences			
Relative risk aversion	γ	1.0	Standard
Technology			
Capital share	α	0.36	Cooley and Prescott (1995)
Interest rate	r	0.002	$\approx$ 2% per year
Depreciation of K	δ	0.006	$\approx$ 5% per year (Gomes, Greenwood, and Rebelo, 2001)
Labor Income			
Persistence and variance of AR(1)	$\{\rho, \sigma_\varepsilon^2\}$	0.900, 0.052	Gomes, Greenwood, and Rebelo (2001)
Government and UI			
Replacement ratio	θ	0.4641	U.S Department of Labor
Monetary requirement	z_{min}	0.5573	Exogenous
Maximum benefit periods	μ_b	24	U.S. Department of Labor
Eligibility requirement	μ_t	24	U.S. States Data

Table 2.3: Endogenously calibrated parameters.

	Parameter	Value	Target	Data	Model
Preferences and Government					
Discount factor	β	0.9974	Wealth/Income	2.5	2.5
Labor disutility	χ	0.3343	Labor force participation rate	0.762	0.819
Transfer to unemployed	T_u	0.049	Transfer to Unemp/Average Lab. Inc.	0.009	0.009
Labor Market Shocks					
Probability of job offer	p_e	0.7977	Weeks receiving UI & shr. exhaust. UI	16 & 0.371	16.1 & 0.371
Probability of losing job	p_u	0.0031	Job destruction	0.028	0.028
Moral Hazard Shocks					
Probability of UI benefit w/o being fired	φ	0.078	Share of agents receiving UI	0.011	0.011
Probability of losing UI exogenously	φ_{exo}	0.1975	Weeks receiving UI & shr. exhaust. UI	16 & 0.371	16.1 & 0.371

2.6 The Benchmark Economy

In Table 2.3 we have shown that the model is able to succesfully match the targeted data moments. In particular, the relevant moments are exactly matched with the only exception of the labor force participation rate which is about 6 percentage points higher than in the data. This can be rationalized by the fact that the universal transfer T_u determined by the calibration target is relatively small and households only have the UI as a source of income beyond their own return to work. As in the design of the UI there are explicit incentives for households to work, the structure of the economy is one of which the forces towards labor force participation compete directly with the preference for lesure.

In order to further understand the validation of our model, we show in Table 2.4 below some selected non-targeted model moments we consider relevant for our environment to be well specified for the quantitative experiments. We can observe that the model is able to closely replicate the mean unemployment duration and the share of workers excluded by the monetary requirement. Notice that the unemployment duration is of around 22 weeks, with on average 8 weeks of duration more than the average period in which workers receive the UI benefit. Hence, the model is able to be precise about the dynamic behavior of the pool of unemployed workers in and out of the labor market and of the insurance system.

The replication of the share of unemployed workers excluded from the benefit by the monetary requirement is key to our analysis as we have exogenously set the requirement z_{min} to an arbitrary small level defined by one the initial points in our discretized shock process. As we match closely the 3.8% share of workers who fall in this category, we can be reassured that for the current computation the monetary requirement has the desired outcome within the model mechanism[4].

Table 2.4: Non-targeted moments of the benchmark economy.

Statistic	**Model**	**Data**
Mean Unemployment Duration	22.77	22.50
UI Expenditure/GDP	0.55%	0.72%
Excluded by Mon. Req.	3.5%	3.8%
Excluded by Tenure Req.	2.9%	8.6%

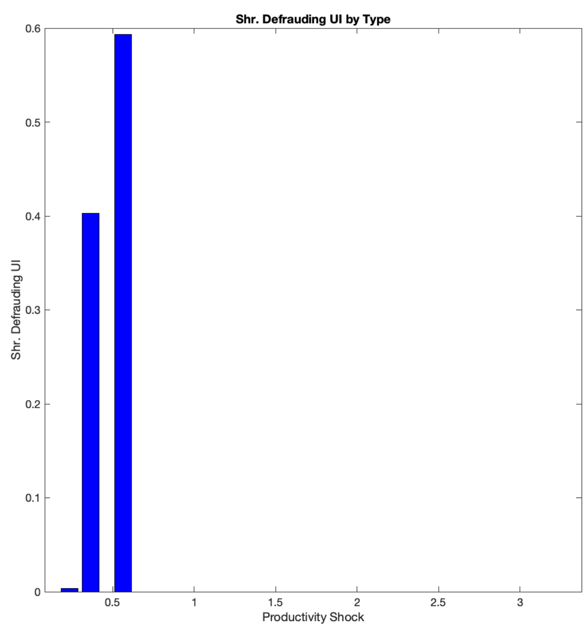
The total expenditure by GDP is also at a level close to what is observed in the U.S. data. This small size of the UI program is also able to be achieved by the existence

[4]The share of workers excluded by the monetary requirement in the data is calculated using the CPS ASEC, being the only part of this survey that has data starting in 1962. For the number shown in Table 2.4, specifically, we take data from the years 2000 to 2015 and merge with our collected database for the monetary requirement. We then compare it to workers' weekly earnings and compute the share that are excluded by the threshold. More details on our calculation of the minimum weekly earnings are described in Appendix 2.A.1

of the universal unemployment transfer T_u, which helps households to have to the correct amount of income and insurance. Hence, with income, job displacement, and moral hazard shocks, the incompleteness of the market ends up self-selecting workers into the UI program and hence achieving the size of the insurance that is given to workers through that channel. Finally, the tenure requirement exclude fewer workers than what is observed in the data.

In Figure 2.1 below we show the share of workers defrauding the UI program, i.e., the share of workers which receive a benefit without being rightfully entitled to do so, by the different levels of the productivity shock. This state of the world is only possible due to the existence of the *moral hazard shock* φ. The idea is to understand what type of workers and jobs are effectively the ones subject to the moral hazard component of the UI and which are the ones that are more likely targeted by the program requirements.

Figure 2.1: Workers defrauding the UI program in the benchmark economy.



One can see in the graph above that the majority of workers who are defrauding the UI are those with low productivity shocks, specially the second and third lowest levels in our calibration. This means that workers with such low productivity are the ones that will seek the insurance component provided by the benefit as deem it as more profitable than the wage they can receive in the market due to their low z. This intuition is behind much of our analysis of the optimality as it is clear that the monetary requirement is an instrument that can directly target this section of the workers' distribution.

2.7 Counterfactual Analyses

In this section we outline the results of the counterfactual exercises conducted highlighting the impacts on the moral hazard component, job-taking behavior and exhaustion of UI benefits. First, we describe the thought experiments and the adaptations in the model required to conduct the counterfactuals. Second, we analyze in subsection 2.7.2 the effect of all elements of the UI design on different types of employment. In section 2.7.3, we discuss the results for the monetary requirement and in 2.7.4 we analyze the effects of changing the tenure requirement.

2.7.1 Thought Experiment

The idea behind the counterfactual exercises of changing the design of UI can be described as follows: we vary the value of policy instrument, say the monetary requirement z_{min}, while keep all other parameters of the UI constant. Naturally, the change of regime in this *coeteris paribus* fashion will affect the endogenous spending and revenues of the UI budget. In order to impose discipline on the government administration of the program, we keep T_u and G fixed at their benchmark's numerical level. We then add and endogenous payroll tax τ_{UI} to finance any residual UI financing needs and close the government's budget. The budget constraint of the household then becomes:

$$c + a' = (1 + (1-\tau)r)a + (1 - \tau - \tau_{UI})wzn + (1-n)T_u + (1-n)b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}}) \quad (2.17)$$

We also need to update the buget constraint of the government under this new regime to add the revenue accruing from the payroll tax τ_{UI}. As it becomes an endogenous object, we can compute it as follows:

$$\tau_{UI} = \frac{G + T_u + \int_S b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})\, d\Phi(s) - \tau \left(r^* K + w^* L + \int_S b^{UI}(\tilde{\mathbf{n}}, \tilde{\mathbf{y}})\, d\Phi(s) \right)}{w^* L} \quad (2.18)$$

We then recover the notion of partial equilibrium of the model economy as described in 2.4.9 by adding τ_{UI} as an endogenous equilibrium object to that definition and substituting condition 3 by equation (2.18). The solution algorithm to find the partial equilibrium now consists on iterating on the underlying fixed point defined by the budget-clearing rate τ_{UI}.

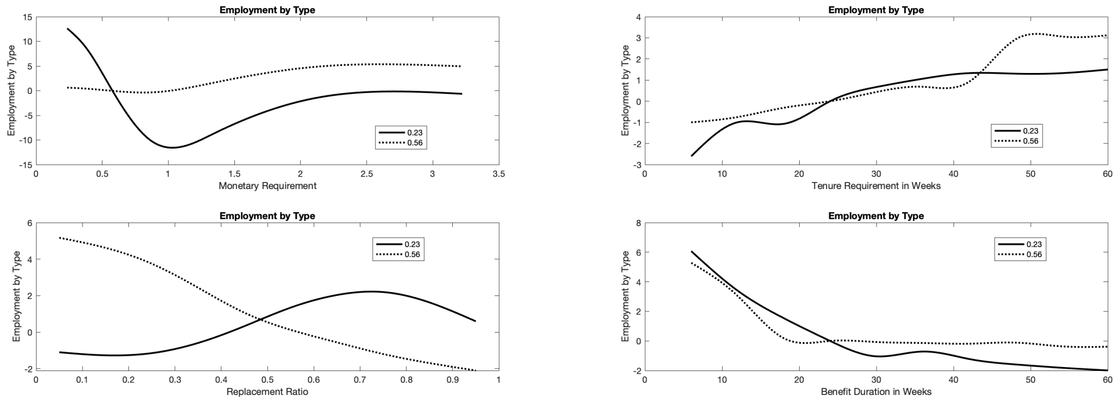
2.7.2 Effects of the UI Design on Employment

In Figure 2.2 below, we show the effect of employment of varying each of the UI design parameters for two of the lowest levels of productivity. The reason we show only for this range is that from the mid-level of the idiosyncratic shock the workers are productive enough so that they basically do not react to changes in the policy instruments in a quantitatively significant manner. The three lowest level of productivity are where we identify relevant behavioral responses.

First, we observe that the share of employed workers by type changes in a way consistent with what was observed in the empirical correlations shown in Table 2.1. Both the monetary and the tenure requirement exhibit in the model a sign and magnitude of their impact that are in accordance to what we have measured in our regressions. More specifically, the tenure requirement is positively associated with employment outcomes whereas the monetary requirement impacts negatively the outcomes. Moreover, the numerical order of magnitude also seem to be preserved, as the tenure requirement has a smaller effect overall than the monetar requirement when measured for the same statistic.

As the benchmark level, the monetary requirement is approximately 0.55. We can then see in the top left panel that it is exactly where both lines cross the zero level. It is possible to observe that the negative relation observed in the data also happens in the model, as when the monetary requirement is made stricter, or higher, there is a overall decrease of the employment rate, specially for the lowest level of productivity. Though not monotone, the intuition follows that a looser monetary requirement for a low productivity worker essentially makes the acces to the UI benefit easier which ends up enlarging the option value of working, together with its built-in work incentives, vis-a-vis the cost of supplying labor.

Figure 2.2: Percentual variation on employment by type for different levels of UI instruments.



Note: Lines are smoothed to facilitate graphical interpretation.

Second we can find an even clearer correlation when analyzing the relative changes in employment due to the changes in the number of weeks of the tenure requirement. Once again, as we start from 22 weeks, we can see in top right panel that both lines for each of the productivity level cross zero at that number. Similarly to what observed in our empirical evidence, the more demanding the tenure requirement, the highest is the share of employment by type. The intuition for this result is straightforward, as with a higher number of weeks required to be able to receive the UI benefits, workers have an extra incentive to remain attached to the labor force. Aside from the lower marginal cost of supplying labor, the benefits are based on the average past earnings, hence the higher the productivity, even at the very bottom of the distributon, the larger the incentive to work.

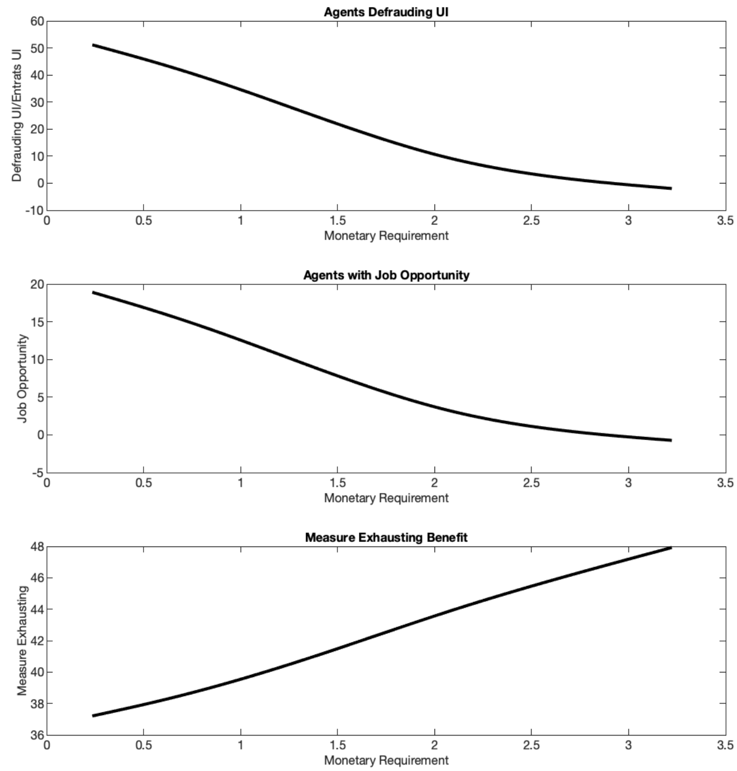
Overall, we can observe that the monetary requirement and the replacement ratio have the strongest impacts on the employment rate when making changes from the benchmark level. The replacement ratio has different effects depending on the workers' productivity. Among the ones depicted, we can observe that the higher the productivity the more positive the impact of a smaller replacement ratio on the employment share of that type. With a higher productivity, a worker has more incentive to actually participate in the labor force if the UI benefit is a smaller fraction of its earnings. Finally, the benefit duration μ_b has an unambiguous impact on workers: the longer the duration of the payment stream, the smaller the incentive for the households to work.

2.7.3 Moral Hazard and the Monetary Requirement

In Figure 2.3 below, we show, from top to bottom graph respectively, the effect of changing the value of the monetary requirement on the workers defrauding the UI benefits, the job opportunity and the measure of worker exhausting the number of periods they are eligible to the benefit.

On the top graph, one can verify that a stricter monetary requirement, higher z_{min}, overalll, reduces the share of workers that defraud the UI over the share of workers entering the UI program. With the lowest possible requirement, such share achieves a level in which about 50% of the workers receiving UI should not be able to receive such benefits. Conversely, if we allow that level to be of the highest possible idiosyncratic productivity, it is possible to decrease this share to zero.

Figure 2.3: Moral Hazard and the monetary Requirement.



Note: Lines are smoothed to facilitate graphical interpretation.

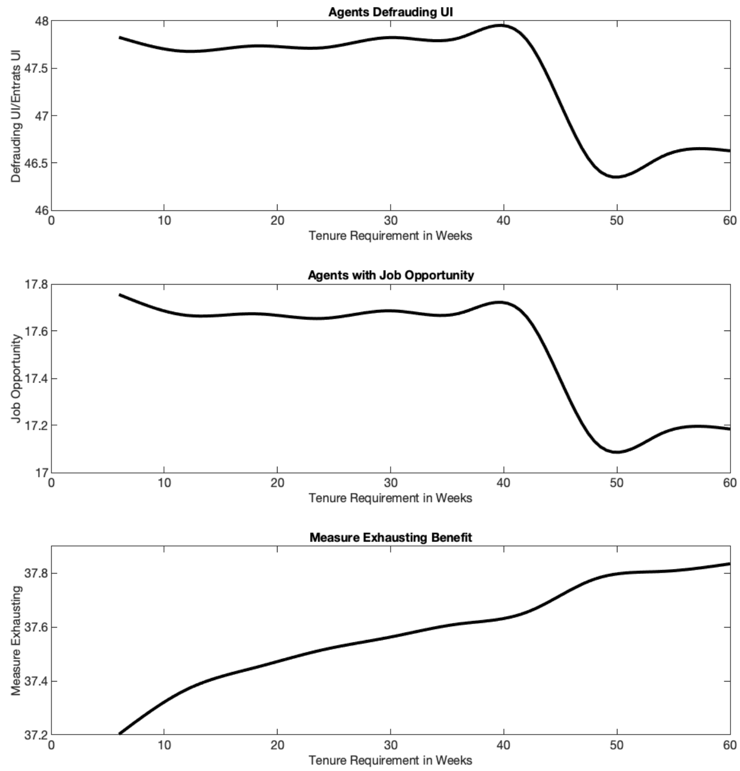
The same inverse relationship happens with the share of workers receiving a job opportunity. With a loose monetary requirement, several workers stay in the unemployment state due to the possibility of collecting undue benefits and thus more than 10% of them are receiving the opportunities for the lowest values of the requirement. Once again, by choosing the strictest possible value of the requirement, one can reduce such share to zero. Finally, the monetary requirement has positively correlated with the share of households exhausting UI benefits. Though, the numerical range of the effect on this measure is smaller than in the previously reported shares. From the last panel, it is clear that a stricter monetary requirement makes it increasingly worthy for workers to use all the time span in which they are entitled to UI benefits, as the chance of receiving them again is lower.

2.7.4 Moral Hazard and the Tenure Requirement

We repeat in Figure 2.4 below the same collection of outcome variables as before but now with the variation of the tenure requirement. A longer tenure requirement, i.e., a higher μ_t, has virtually no effect in all outcomes, which is shown by the small percentage impact on the shares in the figures.

Despite the small quantitative impact, we can see in the bottom graph that the measure of unemployed workers who exhaust completely their UI benefits increases as we require more weeks of work to satisfy the tenure requirement. The same intuition mentioned before for the monetary requirement applies: as the requirement gets stricter, unemployed workers seizing their UI benefits realize it is better to stay in that state until the last possible period in which the insurance is paid.

Figure 2.4: Moral Hazard and the tenure Requirement.



Note: Lines are smoothed to facilitate graphical interpretation.

2.8 Optimal Policy Analysis

We conduct an optimal policy analysis by finding the UI design that maximizes welfare on the economy described. In order to do so, we define a utilitarian Social Welfare Function (SWF) dependent on all relevant policy parameters as follows:

$$W(\theta, \mu_t, \mu_b, z_{min}) = \int v^*(a, z, \bar{n}, m, \bar{y} \mid \theta, \mu_t, \mu_b, z_{min})\, d\mu^* \tag{2.19}$$

where $\{v^*, \mu^*\}$ are, respectively, value function and distribution associated with a stationary partial equilibrium.

Our main goal is not to solve a full Ramsey problem by choosing an optimal sequence of time-dependent policy instruments. Rather, we follow an approach similar to the one used in Krueger and Ludwig (2016). We solve the result of a thought experiment similar to what was already described in our analysis of the counterfactual exercises.

Essentially, we hold constant the income tax τ and the expenditure components G and T_u, as if they were fixed by the government at $t = 0$, and find the combination of static UI policy parameters that optimize the social welfare function subject to it being consistent with a stationary partial equilbrium. This set of partial equilibria to which the planner restricts its attention to, will be the one defined by the households optimization together with the government's budget constraint balanced by τ_{UI}.

In light of this reasoning, the restricted Social Planner's problem is thus defined as:

$$\max_{\{\theta,\mu_t,\mu_b,z_{min}\}\in\Gamma} W(\theta, \mu_t, \mu_b, z_{min}) \tag{2.20}$$

where Γ is the restricted set of policies for which an associated sttionary partial equilibrium exists.

We report the welfare gain in terms of the *Consumption Equivalent Variation* (CEV). This measure defines the increment in consumption that we would need to give households in each state of the world so that they would be indifferent between their level of consumption in the alternative economies. We do so by calculating its *ex-ante* value, hence *under the veil of ignorance*. It is defined for our environment as follows:

$$CEV(\theta, \mu_t, \mu_b, z_{min}) = 100 * \{\exp\left[(1-\beta)\left(W(\theta, \mu_t, \mu_b, z_{min}) - W_{bchmk}\right)\right] - 1\} \quad (2.21)$$

where W_{bchmk} is the SWF associated with the benchmark partial equilibrium parametrized according to Table 2.2.

We show the results in below Table 2.5 below. When optimized in each instrument dimension separately, we can notice that the monetary requirement is the one yielding the highest CEV. The intutition for this result comes from the fact that the monetary requirement prevents households from low wage jobs, who have a high incentive to quit in order to seize the benefit, to defraud the UI program. This is confirmed by the fact that it exhibits the smallest number of beneficiaries of the program, hence diminishing the overall moral hazard faced by the planner.

The second highest level of welfare gain is achieved through a large reduction of the replacement ratio from the initial calibration. When comparing to the benchmark scenario, it becomes clear that the effect of such reduction does not have large incentives on the number of workers that are receiving the benefits. However, it sharply decreases the overall cost of the program with the lowest Expenditure/GDP share of all other instruments at their optimal level. As we effectively find that the budget-clearing rate τ_{UI} is negative, i.e., a transfer, the smaller size of the UI system comes with an lower effective tax rate on payroll when accounting the wedge already imposed by τ.

Table 2.5: Optimal policies and statistics for each of the UI program instruments.

	Data	Replacement Ratio	Benefit Duration	Monetary Requirement	Tenure Requirement	Requirements
Optimal Policies						
Replacement Ratio	0.46	0.15	0.46	0.46	0.46	0.46
Benefit Duration	24	24	6	24	24	24
Monetary Requirement	0.54	0.54	0.54	1.29	0.54	1.29
Tenure Requirement	24	24	24	24	54	12
Statistics						
CEV	0	0.83%	0.58%	0.88%	0.26%	0.99%
Expenditure/GDP	0.55%	0.18%	0.42%	0.31%	0.50%	0.22%
Beneficiaries	1.1%	1.07%	0.40%	0.25%	0.93%	0.27%

We can observe that the tenure requirement yields small welfare gains when considered separately, needing to be at a level of 50 or more weeks, beyond of what we consider in the current computation of the model. Nonetheless, when combined with the monetary requirement, the planner is able to recover the welfare gains by setting the latter at the level associated with the *coeteris paribus* optimal. At the same time though, the planner is able to increase the welfare gains by lowering the tenure requirement to half of what is the benchmark level. This result happens because with a high monetary requirement and low-wage workers defrauding behavior ruled out, a lower tenure requirement yields less workers exhausting their UI benefits as they anticipate they will be able to seize this policy again by taking another job offer with a less restrictive application for the program in the future.

2.9 Conclusion

In this paper, we addressed the question on what are the optimal levels of the two types of requirements used in the UI benefits program in the US. We have developed an infinite horizon partial equilibrium model with incomplete markets and heterogenous agents that includes a UI system that closely mimics the rules observed in the data. The model has a rich individual state-space that includes workers' assets, idiosyncratic shocks and labor supply and income histories. Furthermore, the economy has a structure of shocks that allows the existence of a moral hazard component akin to the one studied in the theoretical literature about optimal UI design. The focus on our analysis lied on the impacts of changes in the UI policy instruments on workers' labor market outcomes.

We conducted an empirical analysis to assess the UI requirements effects on employment outcomes and obtained stylized facts for our quantitative exercises. We used discontinuities in the UI policies to identify the causal effect of the requirements on different labor market outcomes. The monetary requirement has a stronger effect than the tenure requirement on disincentivizing UI benefit applications and a negative effect on the number of employers and on part-time jobs. The tenure requirement has an opposite effect on the latter. The intuition for these results comes from the fact that a tenure requirement does not influence workers to stay at the same job whereas the monetary requirement incentivizes workers to keep high-paying jobs.

We calibrated the model to the US and conducted a series of counterfactual exercises by following a thought experiment that recovered the balance in the government's budget constraint. We were able to recover the negative correlation between the monetary requirement and the employment outcomes and the associated positive correlation with the tenure requirement. In the results of our exercises, we observe that a stricter monetary requirement significantly reduces the share of workers entering the UI system that are not technically qualified to do so. On the other hand, the tenure requirement has negligible numerical impact in labor market outcomes subject to moral hazard.

We have maximized a utilitarian Social Welfare Function (SWF) on a restricted

Ramsey problem and assessed the level of Consumption Equivalent Variation (CEV) associated with the optimal parametric region for the tuple that characterizes the program. In our results, we found that the highest level of welfare is achieved by a monetary requirement when instruments are evaluated separately. A combination of the tenure and the monetary requirement is able to achieve a higher level of welfare than the *coeteris paribus* optimum.

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2.A Appendix

2.A.1 Data

The time period used in our sample is from 1963 to 2016. The data on the labor market is taken from the IPUMS source for the *Annual Social and Economic Supplement* (ASEC) of the *Current Population Survey* (CPS). All the data used regarding the unemployment insurance law for the US states is taken from the *US Department of Labor* (USDL). For the county-level data, we are able to identify respondents' county only after 1996. This restriction reduces significantly our sample of in terms of the UI history and the events of introduction of requirements in some of the states. In order to circunvent this issue we redefine our regional level to be on the border MSAs or the ones that cross between states.

In our sample, each state has its own UI requirements conditionalities and procedure for calculating UI eligibility and benefits. Several of them use a mix of monetary and tenure requirement simultaneously. In order to have a common standard across states and make the classification comparable, we identify as the tenure requirement the minimum employment duration that would make a worker eligible and as the monetary requirement the minimum weekly wage that make the worker eligible.

The source for this data are the USDL tables comparing UI state laws. The standardization for the comparison through time is possible given some choices on the references shown in the tables. The tenure requirement is somewhat straightforward whereas the monetary requirement demands a finer definition. We take face value the numbers shown in the tables for the states that have either a high quarter or a base period definition or both. If there is no tabulation of any numbers, we consider the rule to be absent. We transform these numbers for a weekly basis assuming that the base period is the yearly total and divided it b 48 to recover the weekly equivalent.

Whenever high quarter and base period are present we take the highest among them. In earlier years where it was possible to find a specific weekly wage for some states, we included the value and made the choice of the highest whenever there were other reference periods.

We show the average of these quantities and the time series, respectively, for the monetary requirement below in Figures 2.5 and 2.6 and for the tenure requirement in Figures 2.7 and 2.8.

Figure 2.5: Minimum weekly wage in the US states used in the definition of the monetary requirement.

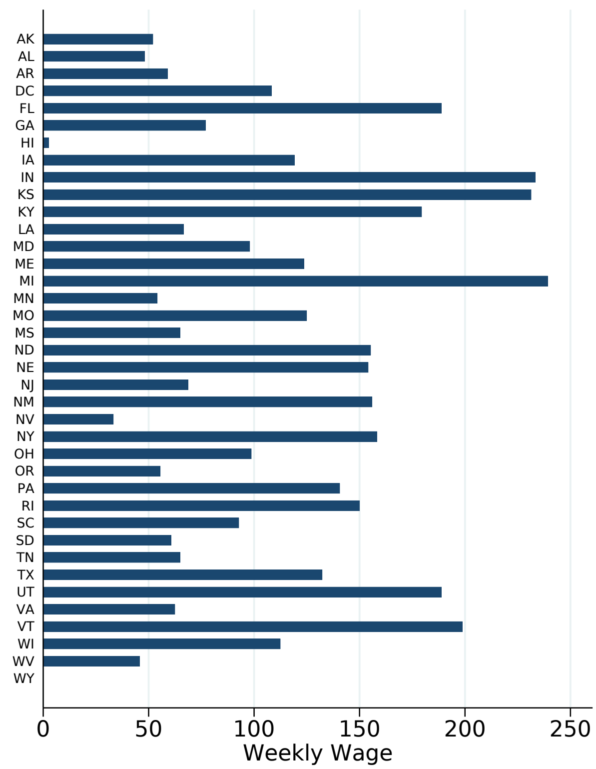


Figure 2.6: Time series from 1950 to 2016 of the minimum weekly wage in the US states used in the definition of the monetary requirement.

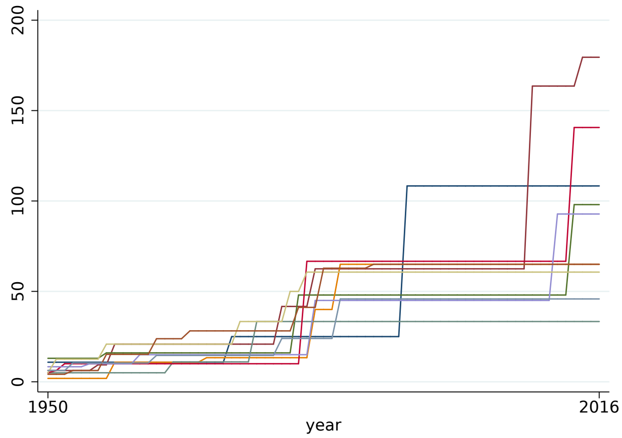


Figure 2.7: Minimum number of weeks in the US states used in the definition of the tenure requirement.

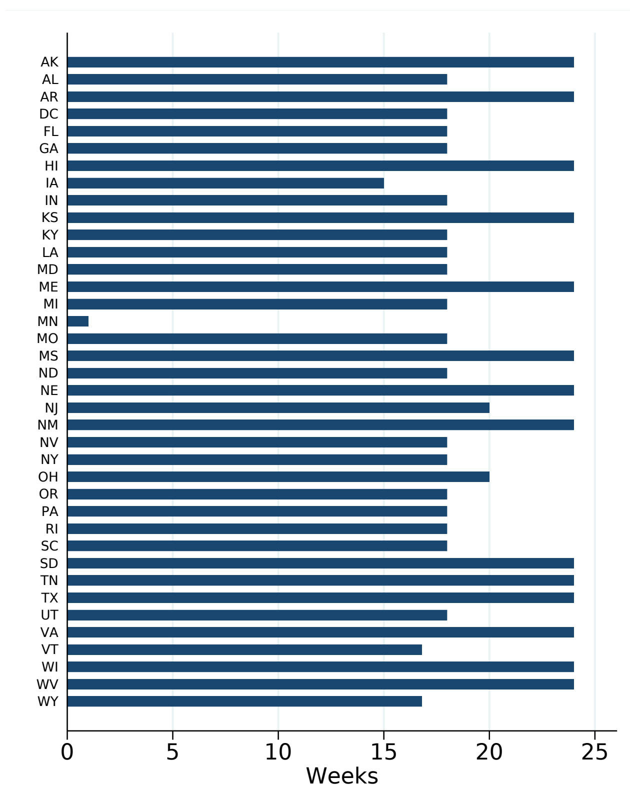
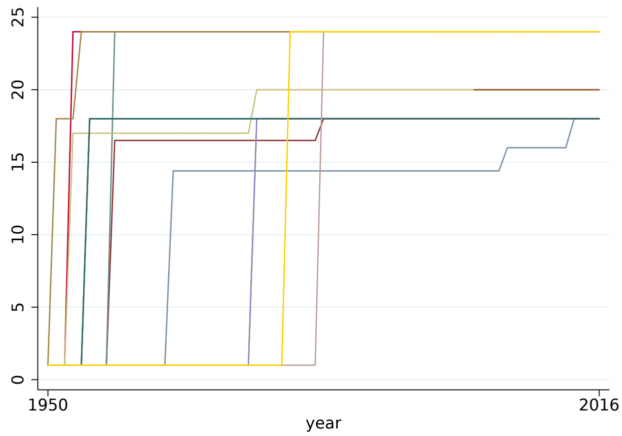


Figure 2.8: Time series from 1950 to 2016 of the minimum number of weeks in the US states used in the definition of the tenure requirement.



2.A.2 Robustness of the Empirical Analysis

We show in this section a few tables containing different regressions for checking the robustness of our empirical findings shown in the main text. First, we calculate estimates using county as the region of observation in Table 2.6 below. We do not find the same significance level across regressions and estimates as with our previous choice. This is due to the fact that our panel is substantially longer when using the MSA definition.

Table 2.6: Robustness of the econometric analysis at the county level.

	(1)	(2)	(3)	(4)
	UI Last Year	# Employers Last Year	Part Time	Duration Last Job
log(monreq)	-0.00456	-0.0189**	-0.0323*	0.434
	(0.195)	(0.012)	(0.058)	(0.203)
log(tenurereq)	0.00496	0.00505	0.0263*	0.230*
	(0.154)	(0.549)	(0.062)	(0.073)
Region	County	County	County	County
Border-Year FE	X	X	X	X
Region FE	X	X	X	X
N	193712	135764	149407	1485
R^2	0.017	0.040	0.073	0.439

p-values in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Note: The variable log is the logarithm of the numerical variable associated with the definition of tenure or monetary requirement. Outcome variables for regressions (1), (3), (4) are dummies indicating the ocurrence of the variable in the previous year. Outcome variable for regression (2) is numerical and continuous. The results are shown for the coefficient of interest of a regression with control variables for demographic characteristics.

In our preferred specification in the main body of the text we have used an indicator for the presence of the requirements in the results shown in Table 2.1. As we have used a log formulation in the robustness checks shown in Table 2.6 for the county-level observations, we use the same one for in Table 2.7 below:

Table 2.7: Robustness of the econometric analysis at the MSA level.

	(1)	(2)	(3)	(4)
	UI Last Year	# Employers Last Year	Part Time	Duration Last Job
log(monreq)	0.000237	0.00305	-0.00761	0.314
	(0.887)	(0.614)	(0.244)	(0.151)
log(tenurereq)	0.000159	0.0216***	0.00858***	0.662***
	(0.887)	(0.000)	(0.000)	(0.001)
Region	MSA	MSA	MSA	MSA
Border-Year FE	X	X	X	X
Region FE	X	X	X	X
N	222656	111422	124584	1485
R^2	0.899	0.052	0.086	0.336

p-values in parentheses

* p<0.10, ** p<0.05, *** p<0.010

Note: The variable log is the logarithm of the numerical variable associated with the definition of tenure or monetary requirement. Outcome variables for regressions (1), (3), (4) are dummies indicating the ocurrence of the variable in the previous year. Outcome variable for regression (2) is numerical and continuous. The results are shown for the coefficient of interest of a regression with control variables for demographic characteristics.